

L461
J72*
101
p. 3
uly 1993

01

JULY 1993

No. 3

Journal of the New York Entomological Society

(ISSN 0028-7199)



Devoted to Entomology in General

JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY

Editor: James M. Carpenter, Department of Entomology, American Museum of Natural History, Central Park West at 79th Street, New York, New York 10024

Book Review Editor: James S. Miller, Department of Entomology, American Museum of Natural History, Central Park West at 79th Street, New York, New York 10024

Publications Committee: James K. Liebherr, Cornell University, Ithaca, Chairman; David L. Wagner, University of Connecticut, Storrs; Alfred G. Wheeler, Jr., Pennsylvania State Department of Agriculture, Harrisburg.

The New York Entomological Society Incorporating The Brooklyn Entomological Society

President: Randall T. Schuh, Department of Entomology, American Museum of Natural History, New York, New York 10024

Vice President: Sule Oygur, Department of Entomology, American Museum of Natural History, New York, New York 10024

Secretary: Rajeev Vaidyanathan, Medical Entomology Laboratory, New York Medical College, Valhalla, New York 10595

Treasurer: Louis Sorkin, Department of Entomology, American Museum of Natural History, New York, New York 10024

Trustees: *Class of 1991*—Christine Falco, White Plains, New York; Theodore Weisse, Northport, New York. *Class of 1992*—Durland Fish, Valhalla, New York; Richard Falco, White Plains, New York.

Annual dues are \$23.00 for established professionals with journal, \$10.00 without journal, \$15.00 for students with journal, \$5.00 without journal. Sustaining memberships are \$53.00 per year, institutional memberships are \$125.00 per year, and life memberships are \$300.00. Subscriptions are \$45.00 per year domestic, \$50.00 Mexico and Canada, \$55.00 all other countries. All payments should be made to the Treasurer. Back issues of the *Journal of the New York Entomological Society*, the *Bulletin of the Brooklyn Entomological Society*, *Entomologica Americana* can be purchased from Lubrecht and Cramer, RD 1, Box 244, Forestburgh, New York 12777. The *Torre-Bueno Glossary of Entomology* can be purchased directly from the society at \$45.00 per copy, postage paid.

Meetings of the Society are held on the third Tuesday of each month (except June through September) at 7 p.m. in the American Museum of Natural History, Central Park West at 79th Street, New York, New York.

Mailed October 18, 1993

The *Journal of the New York Entomological Society* (ISSN 0028-7199) is published 4 times per year (January, April, July, October) for the Society by Allen Press, Inc., 1041 New Hampshire, Lawrence, Kansas 66044. Second class postage paid at New York, New York and at additional mailing office. Postmaster: Send address changes to the New York Entomological Society, c/o American Museum of Natural History, Central Park West at 79th Street, New York, New York 10024-5192.

Known office of publication: American Museum of Natural History, New York, New York 10024.
Journal of the New York Entomological Society, total copies printed 700, paid circulation 602, mail subscription 602, free distribution by mail 19, total distribution 621, 79 copies left over each quarter.

**THE BLACK FLIES OF THE GENUS *SIMULIUM*,
SUBGENUS *PSILOPELMIA* (DIPTERA: SIMULIIDAE), IN
THE CONTIGUOUS UNITED STATES**

B. V. PETERSON

Systematic Entomology Laboratory, PSI, Agricultural Research Service,
U.S.D.A., % National Museum of Natural History,
Washington, D.C. 20560

Abstract.—Keys, descriptions, and illustrations are provided to aid in the identification of the females, males, pupae and larvae, where each is known, of the eight species assigned to the subgenus *Psilopelmia*, of the genus *Simulium*, in the contiguous United States. Two species, *S. (P.) labellei*, and *S. (P.) robynae*, are described as new. Remarks concerning the taxonomy and biology of each species are provided, and the known distributions by state and county are given.

TABLE OF CONTENTS

Abstract	301
Introduction	301
Materials and Methods	302
Taxonomic Treatment	304
Genus <i>Simulium</i> , Subgenus <i>Psilopelmia</i>	304
Keys to the Species of <i>Psilopelmia</i> in the Contiguous United States	305
Females	305
Males	305
Pupae	307
Larvae	308
Species Descriptions	308
<i>Simulium (P.) bivittatum</i> Malloch	308
<i>Simulium (P.) griseum</i> Coquillett	319
<i>Simulium (P.) mediovittatum</i> Knab	329
<i>Simulium (P.) notatum</i> Adams	338
<i>Simulium (P.) trivittatum</i> Malloch	341
<i>Simulium (P.) venator</i> Dyar and Shannon	353
<i>Simulium (P.) labellei</i> Peterson, new species	360
<i>Simulium (P.) robynae</i> Peterson, new species	368
Acknowledgments	382
Literature Cited	383

This paper treats eight species of the subgenus *Psilopelmia* Enderlein, of the genus *Simulium* Latreille. It is the first of several works intended to treat the species of various subgenera of the genus *Simulium*. This study has some applicability to the fauna of Canada and Mexico, but emphasis has been placed on the species within the contiguous United States.

Table 1. Biting Records

HOSTS	Black Fly Species							
	bivittatum	griseum	labellei	mediovittatum	notatum	robynae	trivittatum	venator
Man	X	X		X			X	X
Horse	X	X		X		X	X	X
Mule				X				
Donkey				X				
Cattle	X	X				X?	X	
Dog								X
Rabbit		X		X		X		
Hawk	X?							
Owl	X?							

This paper is a descriptive work with keys and figures to facilitate the identification of the species treated, some of which are pests of livestock and, to a lesser extent, other animals and man (Table 1). It deals with the morphospecies level of black fly identification, or the species as they are currently known. Hopefully, it will be of use to other systematists who may eventually utilize cytotaxonomic or other techniques to check for cryptic species, or attempt a phylogenetic analysis of the group.

MATERIALS AND METHODS

The males of each species are rather uniform in their color patterns, and these patterns, in combination with genital characters, usually allow accurate identification. On the other hand, the yellowish females are quite variable in their color patterns and intensity. This variability, whether naturally occurring or due to recency of emergence or other factors, is especially evident between dry, pinned specimens and those preserved in fluid. With experience, most specimens can be reliably identified to species despite such color variations. However, there are both male and female specimens that somehow defy identification, and no claim is made that the keys will allow perfect identification of all specimens. The pupae and larvae are much more difficult to separate but the keys should be helpful in most cases. Freshly preserved, mature larvae (those with darkened respiratory histoblasts) and pupae are easier to identify than immature specimens or those that have been preserved for a long time in fluid. Both the keys and descriptions were prepared using recently collected, or other available, reared adults and their associated pupal pelts and mature larvae.

Because most black fly genera contain cryptic species complexes, some, or perhaps all of the species recognized here by morphological features may eventually prove to consist of such complexes. As part of this study I wanted to determine, if possible,

whether the various thoracic color patterns were due, at least in part, to some microstructure of the integument of the dorsum of the thorax, or if these patterns were due to pigment or other factors. As can be seen by the appropriate micrographs (Figs. 130–132, 135, 141, 143, 150–151), color patterns probably are due, at least in part, to the microstructure (microtomentum) of the thorax. Hannay and Bond (1971b) working with *Simulium vittatum* Zetterstedt, and Lowry and Shelley (1990) using three Neotropical species of *Simulium*, demonstrated structures, similar to those shown here, that they indicate are responsible for various thoracic color patterns. This approach may prove useful in separating cryptic species that are so prevalent in the Simuliidae, if such resolutions are possible.

This study was based largely on material available in the collection at the National Museum of Natural History, Smithsonian Institution (USNM), and that collected and reared by the author over the past several years. Holotypes, and other important supplementary material, were furnished from institutional and personal collections as listed in the acknowledgments. As a result, types of all the valid and synonymous species mentioned in the text have been examined.

To conserve space, distribution records are listed by state and county, in alphabetical order, followed by the earliest and latest collection dates within each county, and the life history stages of available material (A = adults, P = pupae, L = larvae). A complete list of locality data is available from the author upon request, and is on file at the National Museum of Natural History.

In the literature citations of the synonymies, I usually give the page number of the first occurrence of the name. However, in a few instances I give the page number on which the most important discussion or notation of the taxon appears. An effort was made to include as many references for each taxa as possible. Because it was impossible to examine representative specimens from all of the studies cited, I simply accepted the identifications of most authors. Consequently, I cannot vouch for the accuracy of many of their identifications. Obvious or suspected misidentifications are indicated in the appropriate places in the text.

Most of the illustrations used in this paper were prepared by various artists with the former 406th Medical General Laboratory, U.S. Army, Japan (see acknowledgments). A few of these apparently were made from pale specimens, or show features in a slightly different way or from a slightly different angle than described in the text. This does not negate either the figure or the description of such features in those few instances where such differences occur (e.g., some leg patterns, ventral view of ventral plate of the aedeagus, larval head capsules).

The scanning electron micrographs that accompany this paper were made from reared specimens stored in alcohol, dehydrated using a critical point dryer, and prepared for SEM study. Most of the micrographs were made using a Cambridge Stereoscan 100, while those at very high magnifications were made with either the Cambridge Stereoscan 250 Mk 2, or the Hitachi Model 570. Micrographs were made of structures that were difficult to see under a dissecting or compound microscope. It was not always possible to obtain the same views of these structures, and micrographs of some parts could not be obtained.

The terminology employed in this study is essentially that used by Peterson (1981) with the few minor exceptions as described and used by Currie (1986).

TAXONOMIC TREATMENT

Genus *Simulium* LatreilleSubgenus *Psilopelmia* Enderlein

Psilopelmia Enderlein, 1934:283 (as genus). Type species: *Psilopelmia rufidorsum* Enderlein (original designation) = *Simulium escomeli* Roubaud (Vargas and Díaz Nájera, 1953a:146). Smart, 1945:465. Vargas, 1945c:101. Vargas and Díaz Nájera, 1957:158; Vargas and Díaz Nájera, 1959:110; Hidalgo Escalante, 1959:28; Stone, 1963:16; Stone, 1965:186; Vulcano, 1967:5. Rubtsov, 1968:358; Crosskey, 1969:68; Rubtsov, 1974:276; Peterson, 1981:376; Coscarón, 1987:30; Crosskey, 1988:433.

Lanea Vargas, Martínez Palacios and Díaz Nájera, 1946:103. Type species: *Simulium haematopotum* Malloch (orig. desig.). Vargas and Díaz Nájera, 1948a:69. Vargas and Díaz Nájera, 1948b:322. Vargas and Díaz Nájera, 1949:285. Vargas and Díaz Nájera, 1951a:130. Dalmat, 1955:69; Stone, 1963:11. Vulcano, 1967:5. Crosskey, 1988:466.

The literature cited in the synonymy includes only those papers that contain a characterization of the subgenus, include keys for distinguishing the various life history stages from those of other subgenera, or which include this subgenus in catalogs and lists.

The subgenus *Psilopelmia* has been amply characterized by Stone (1963), Coscarón (1987), and, to a much lesser extent, Crosskey (1969). The subgenus, based upon the species studied for this report, can be characterized as follows:

ADULTS: Basal section of R bare; Sc without setae ventrally. Thorax usually with at least some yellow or orange areas, and often densely pruinose, or with a bold dorsal pattern of one or more variably elongate, straight or curved stripes. Calcipala usually small and inconspicuous but may extend to or slightly beyond pedisulcus. **FEMALE:** Fronto-ocular triangle present; frons pruinose; cibarium with variably developed setalike or broader denticles. Hind tibia slender, without noticeable angle; hind basitarsus not widened; claw weakly curved, without a subbasal tooth but may have a fairly well developed heel. Lower margin of anal lobe not emarginate, either angulate or attenuate below and sometimes extended well below ventral margin of cercus. **MALE:** Gonostylus about $\frac{1}{2}$ as long as gonocoxite, flattened, quadrangular, distal margin subtruncate with a variably prolonged or acute inner distal angle bearing a single short spine; base of paramere corrugated, arms with variably developed spines, apex of arms sometimes with a slender, wrinkled, membranous, rodlike process that extends internally from tips of arms of paramere (I have not seen this feature among other North American black flies). **PUPA:** Thorax usually but variably granulose dorsally. Abdomen with transverse rows of spines on more than tergites 2–4, those on 8 at least 16 in number; some dorsal spines on abdomen in contiguous comblike rows; terminal spines present but small; ventral spines present on sternites 4–6. Respiratory organ (gill), with 6–8 long, pale whitish to yellowish, slender filaments. Cocoon slipper-shaped, usually tightly woven with variably thickened anterodorsal margin. **LARVA:** Antenna pale, without annulations or transverse striations; cervical sclerites small, not strongly developed; hypostomal cleft broadly rounded, variably deep but never reaching base of hypstoma; mandible with 1 or 2 serrations on inner subapical margin. Anal setulae usually present but minute; posterior circlet

with less than 120 (usually less than 80) rows of hooklets; ventral tubercles usually present but small.

Keys to separate the adults and immature stages from those of other Mesoamerican subgenera can be found in the various papers of Vargas and Díaz Nájera listed above, and that of Dalmat (1955). Keys for the separation of the adults and larvae of this subgenus from other Nearctic taxa were given by Peterson (1981).

KEYS TO THE SPECIES OF THE SUBGENUS *PSILOPELMIA* IN THE
CONTIGUOUS UNITED STATES

Females

1. Thorax, in lateral view, conspicuously arched dorsally and higher than normal, anterior face of scutum nearly vertical (Figs. 82, 95, 110, 112) 2
- 1'. Thorax, in lateral view, not conspicuously arched dorsally or higher than normal, anterior face of scutum sloped upward and backward 3
2. Yellow to orange species, if black then thorax with distinct patches of yellow or orange color. Terminalia as in Figures 102, 121 *robrynae*, n. sp.
- 2'. Entirely black species except postpronotal lobes yellow. Terminalia as in Figures 89, 120 *labellei*, n. sp.
3. Scutum unicolorous, ground color yellowish to black, with a variably dense grayish pruinosity, without distinct stripes (stripes often discernible in alcohol preserved specimens) (Fig. 22) 4
- 3'. Scutum with 1 to 7 distinct stripes (visible in both dry and alcohol preserved specimens) (Figs. 5, 39, 56, 70) 5
4. Scutum entirely to largely yellowish orange, at most with a faint pruinosity; legs entirely yellow; a small species, about 1.69 mm long. Terminalia as in Figure 51 *notatum*
- 4'. Scutum dark yellowish brown to black, densely grayish pruinose and often with a faint greenish yellow hue (Fig. 22); somewhat larger species, 1.82–3.25 (av 2.59) mm long. Terminalia as in Figure 26 *griseum*
5. Scutum with a single, median, usually narrow, reddish to brown stripe, remainder of scutum rather uniformly brown to black with a dense grayish pruinosity (Figs. 39, 70) 6
- 5'. Scutum with 7 alternating light and dark stripes, with grayish pruinosity only on the light stripes (Figs. 5, 56) 7
6. Anal lobe with, at most, a short, ventral convexity or lobelike process (Fig. 43b) (verified only from Texas) *mediovittatum*
- 6'. Anal lobe with a conspicuous, ventral, digitiform process (Fig. 77b) (more widely distributed) *venator*
7. Dark stripes on scutum distinctly yellowish orange; a pale yellowish species (Fig. 5). Ventral digitiform process of anal lobe somewhat variable in length but not long enough for tips to cross in normal position (Fig. 10) *bivittatum*
- 7'. Dark stripes on scutum dark brown to black; a darker species (Fig. 56). Ventral digitiform process of anal lobe long, slender, with a tuft of apical setae, the processes of both sides somewhat variable in thickness but always long enough to cross each other in normal position (Figs. 61, 136) *trivittatum*

Males

(Male of *notatum* not known)

1. Thorax, in lateral view, conspicuously arched dorsally, higher than normal, anterior face of scutum nearly vertical, top of head distinctly below top of thorax and often about on a level with top of scutellum (Figs. 111, 113) 2

- 1.' Thorax, in lateral view, normal, not conspicuously arched or higher dorsally than normal, if conspicuously arched, then anterior face of scutum distinctly sloping posterodorsally, top of head often nearly as high as top of thorax 3
2. Pale brownish yellow species. Arm of paramere with 2 basal spines that are slightly stronger and more distinct than remaining parameral spines. Ventral plate of aedeagus, in ventral view, as in Figures 101, 119 *robynae*, n. sp.
- 2.' Black species. Arm of paramere with 4–5 basal spines that are stronger and slightly more distinct than remaining spines. Ventral plate of aedeagus, in ventral view, as in Figures 88, 118 *labellei*, n. sp.
3. Thoracic ground color dark brown to black, strongly contrasting with submedian and lateral pruinose stripes; 2 submedian stripes bright grayish pruinose, that reach and merge with pruinosity of posterior declivity 4
- 3.' Thoracic ground color variable; scutum without 2 submedian, grayish, pruinose stripes that reach pruinosity of posterior declivity; however, 2 variably developed but shorter, submedian, anterior pruinose spots may be present 5
4. Scutum with 2 large, submedian, triangular spots that strongly taper posteriorly and continue as 2 very slender, pruinose stripes that merge with pruinosity of posterior declivity. Ventral plate of aedeagus, in ventral view, broadly triangular with somewhat rounded lateral angles (Fig. 42). Arm of paramere with 2–4 (usually 2) strong, well defined, basal spines that are continuous with a distal cluster of 15 or more smaller, closely placed and less well defined spines among which may be 2–4 better defined spines that approach the basal spines in size and development *mediovittatum*
- 4.' Scutum with 2 broader, submedian, nearly straight or less tapered, pruinose stripes that merge with pruinosity of posterior declivity (Fig. 57). Ventral plate of aedeagus broadly subtriangular; in ventral view, lateral margins tapered distally to apical margin which, in flat view, is straight or slightly convex, or if basal arms somewhat tilted ventrally (inwardly) then apical margin curved with a short, broadly rounded, median point (Fig. 60). Arm of paramere with 4–5 basal spines that are much longer, broader, and better defined than apical spines *trivittatum*
5. Thoracic ground color paler and more yellowish to orange brown; scutum, dorsally, matte black, at most faintly pruinose; viewed from in front with 2 outwardly curved, bright grayish pruinose, submedian, triangular spots that originate at posterior edge of anterolateral yellow area of scutum and extend posteriorly about $\frac{1}{2}$ – $\frac{3}{4}$ distance to base of wing. Ventral plate of aedeagus, in ventral view, distinctly rectangular, with distal margin nearly straight to slightly curved. Arm of paramere with, at most, a few enlarged, basal spines, but these not conspicuously larger or better defined than apical spines (Fig. 9) *bivittatum*
- 5.' Thoracic ground color darker brown to black; scutum, dorsally, distinctly grayish pruinose, and submedian scutal spots, if present, much narrower and shorter. Ventral plate of aedeagus, in ventral view, subtriangular to subrectangular. Arm of paramere variable (Fig. 76) 6
6. Thorax black, with 2 short, submedian spots. Ventral plate of aedeagus, in ventral view, rather slender and subquadrate or, depending on angle of view, subtriangular and tapered distally to a point. Arm of paramere with a series of poorly defined spines, basal 3–4 of which are shorter, stouter, and better defined (Fig. 76) *venator*
- 6.' Thorax brown to black, densely grayish pruinose. Ventral plate of aedeagus, in ventral view, broad, subquadrate, with distal margin broadly rounded or nearly straight. Arm of paramere with 6–8 larger and well defined basal spines and 8–12 smaller, weaker, poorly defined spines (Fig. 25) *griseum*

Pupae
(Pupa of *notatum* not known)

1. Thorax of pupa, in lateral view, distinctly separated from head, anterior face of thorax nearly vertical and projected dorsally well above level of top of head; anterolateral margin of thorax with a vertical row of about 4 conspicuous, multibranched trichomes on each side (Figs. 92, 93). Respiratory organ (gill) with 8 filaments 2
- 1.' Thorax of pupa, in lateral view, nearly continuous with posterodorsal portion of head, anterior face of thorax variably curved dorsally and usually not projected as much above level of top of head (Figs. 16, 32, 80); if conspicuously projected dorsally above level of head (particularly male pupae) then anterolateral margin of thorax without a row of conspicuous multibranched trichomes. Respiratory organ with 6–8 filaments 3
2. Thorax with a multibranched trichome, similar to those on anterior face of scutum, just posterior to base of respiratory organ and just anterior to anteroventral angle of wing sheath; dorsal surface of thorax with 2 fanlike and 1–3 long single trichomes on each side. Head with numerous closely placed granules, these less numerous on dorsum of thorax *labellei*
- 2.' Thorax with 2–3 posterolaterally situated, dorsal trichomes that are long and simple or bifurcate. Head and thorax with numerous, tiny, closely placed granules *robynae*
3. Respiratory organ with 6 filaments branching 2+2+2 (dorsal-ventral) (rarely with 7 filaments branching 3+2+2) *trivittatum*
- 3.' Respiratory organ with 8 filaments branching 3+3+2 (dorsal-ventral) 4
4. Respiratory organ with 3 groups of filaments branching (2+1) + (2+1) + 2 (dorsal, medial, ventral), the dorsal group on short petioles, the medial and ventral groups on longer petioles (Fig. 50). Anterior margin of cocoon with only a slightly thickened, narrow rim (Fig. 49) *mediovittatum*
- 4.' Respiratory organ with 2–3 groups of filaments, mediolateral group branching (1+2) not (2+1) as above (Fig. 17). Anterior margin of cocoon variable but usually distinctly thickened (Figs. 16, 32, 67) 5
5. Cocoon rather coarsely woven so that there often are distinct thicker and thinner areas, anterior margin only slightly thickened; in lateral view, anterolateral margin nearly straight but variably slanting anteromedially, anteroventral corners of cocoon variably produced inwardly and, at times, they meet or nearly so to produce a narrow, anteroventral collarlike lip or rim (Fig. 80). Tergite 5 bare; tergites 6–9 each with a row of short, fine, posteriorly directed spinules near anterior margin, those of 6 sometimes reduced in number; this spine row of 6–7 separated by a median gap, but those of 8–9 complete; this row of 7 continuous laterally with a few much smaller, comblike spinules *venator*
- 5.' Cocoon more tightly and uniformly woven, without distinct thicker and thinner areas; anterior margin of cocoon distinctly thickened. Other characters not as above 6
6. Cocoon, in lateral view, with anterolateral margin nearly straight vertically or only slightly slanting so that anteroventral corner of cocoon usually extends only slightly in front of dorsal margin (Fig. 16). Tergite 5 bare except for a small patch of minute spinules anterolaterally; tergite 6 with several small comblike series of minute spinules that merge laterally with an anterolateral patch of even smaller spinules, numbers of both types of spinules variable *bivittatum*
- 6' Cocoon, in lateral view, with anterolateral margin slightly concave but distinctly sloping forward so that up to about $\frac{1}{3}$ of its total length extends in front of dorsal rim (Fig. 32). Tergite 5 and usually 6 bare, but if spinules present on 6 then without an anterolateral patch of minute spinules *griseum*

Larvae

(Larva of *notatum* not known)

1. Labral fan usually with fewer than 45 primary rays 2
- 1.' Labral fan usually with 50 or more primary rays 5
2. Frontoclypeal apotome usually with light brown but generally distinct head spots (Fig. 11) (head spot pattern often resembles that of *S. venustum* Say complex); hypostomal bridge distinctly longer than hypostoma (more rarely subequal). Labral fan with 30–40 primary rays. Posterior circlet with 70 or more rows of hooks *bivittatum*
- 2.' Frontoclypeal apotome usually without distinct spots, if spots faintly visible, then hypostomal bridge either shorter or subequal in length to hypostoma. Labral fan with variable number of primary rays. Posterior circlet with variable number of rows of hooks 3
3. Antenna distinctly brown to pale brown except base of proximal and distal antennomeres, and apex of middle antennomere which are colorless. Hypostomal cleft, hypostomal bridge and hypostoma subequal in length. Labral fan with about 34–36 primary rays. Posterior circlet with 60–70 rows of hooks *trivittatum*
- 3.' Antenna faintly yellowish or faintly brownish on upper surface and transparent on lower surface. Hypostomal cleft, hypostomal bridge, and hypostoma variable in length. Posterior circlet with variable number of rows of hooks 4
4. Hypostomal cleft extended about $\frac{2}{3}$ distance to base of hypostoma. Labral fan with 30–36 primary rays. Posterior circlet with about 60 rows of hooks *griseum*
- 4.' Hypostomal cleft extended over $\frac{1}{2}$ distance to base of hypostoma. Labral fan with about 36 primary rays. Posterior circlet with 75–80 rows of hooks *venator*
5. Antenna longer than stalk of labral fan by $\frac{1}{2}$ or more length of distal antennomere; entirely pale yellowish. Posterior circlet with about 85–90 rows of hooks *robynae*
- 5.' Antenna at most slightly longer than stalk of labral fan; at least basal 2 antennomeres transparent whitish to colorless. Posterior circlet with fewer than 80 or more than 100 rows of hooks 6
6. Posterior circlet with about 68–76 rows of hooks. Basal 2 antennomeres colorless, distal antennomere faintly brownish *mediovittatum*
- 6.' Posterior circlet with about 110–116 rows of hooks. Antenna entirely transparent whitish *labellei*

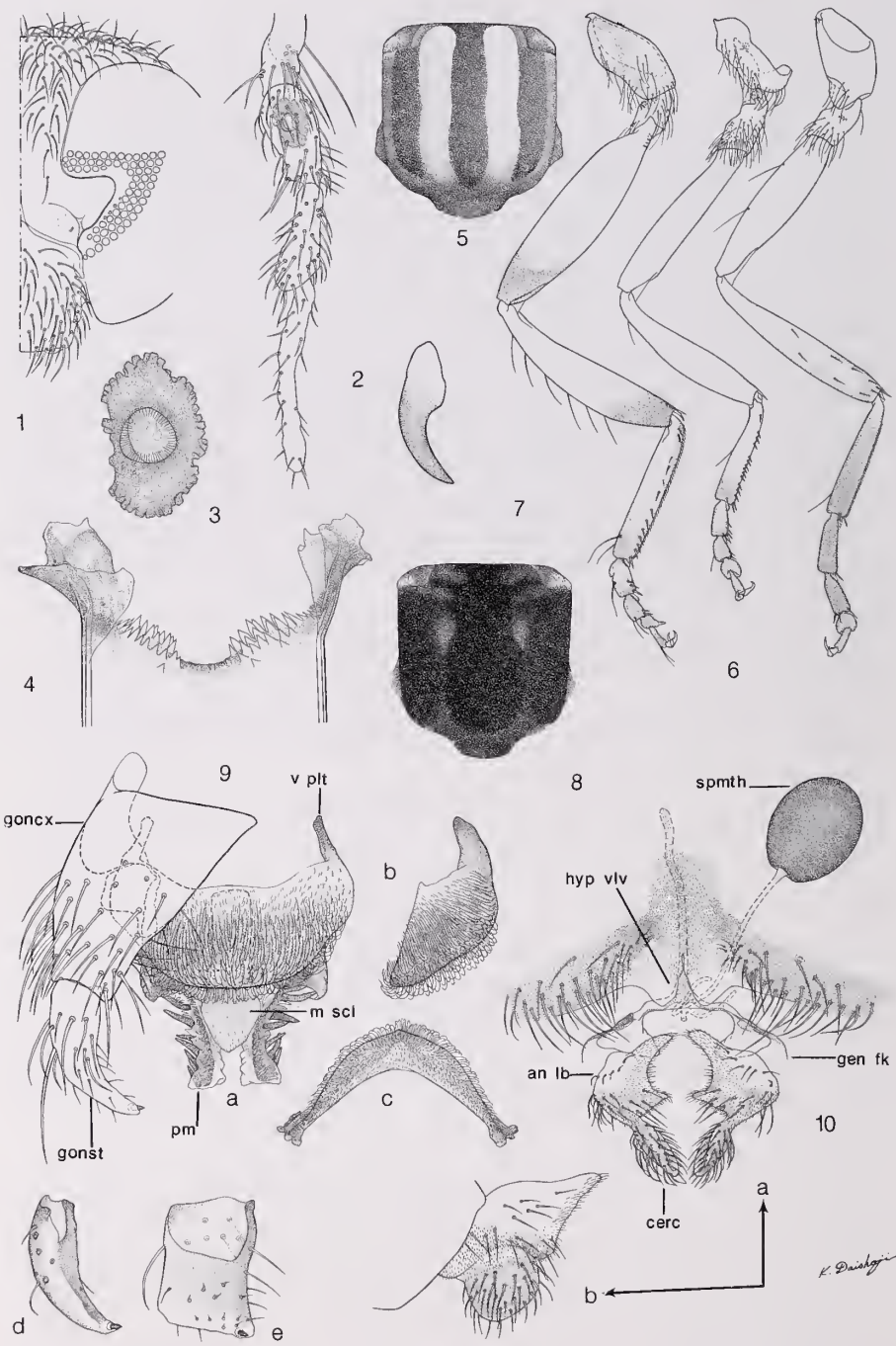
SPECIES DESCRIPTIONS

Simulium (Psilopelmia) bivittatum Malloch

Figs. 1–17

Simulium bivittatum Malloch, 1914:31 (♀, original description, key, catalog, fig. 7); holotype ♀, Type #15415 (USNM). Knab, 1914:83 (citation); Knab, 1915a (as 1914):179 (citation); Cole and Lovett, 1921:227 (biting bathers in Oregon); Cameron, 1922:4 (citation); Dyar and Shannon, 1927:37 (♀, key, description); Enderlein, 1930:96 (♀ head); Hearle, 1932:18 (citation); Knowlton, 1935:1073 (annoying horses); Essig, 1938:552 (biting bathers in Oregon); Knowlton, Harmston and Hardy, 1938:104 (Idaho); Twinn, 1938:54 (distribution in Idaho); Stains and Knowlton, 1943:278 (♀, ♂, key, description, figs. 81–82, 122–123, 125); Smart, 1945:502 (catalog); Vargas, 1945a:77 (♀ differentiated from *S. mangabeirai* Vargas); Vargas, 1945c:120 (catalog, synonymy, distribution); Knowlton and Fronk, 1950:5 (Utah); Pan Amer. Sanit. Bur., 1950:160 (literature reference (wrong reference cited, should be 770, not 769)); MacNay, 1954:156 (Saskatoon); MacNay, 1955:201 (Alberta); Peterson, 1955:114 (Utah); Fredeen, 1956:4 (Alberta); MacNay, 1956:291 (Al-

- berta); Rubtsov, 1956:748 (citation); Fredeen, 1958:820 (Alberta); MacNay, 1958b: 272, (Saskatchewan, attacking horses); MacNay, 1958c:340 (Saskatchewan, attacking horses); MacNay, 1959a:41 (Saskatoon, annoying horses); MacNay, 1959b: 138 (Saskatoon, annoying horses); Peterson, 1959:151 (biting records); Peterson, 1960a:267 (predators); Peterson 1960b:99 (♀, ♂, pupa, key, distribution, type, type locality); Wiseman and Eads, 1960:46 (Texas records); Fredeen and Shemanchuk, 1960:729 (biological notes, Alberta); MacNay, 1961c:15 (Saskatoon, annoying horses); MacNay, 1962:179 (biting humans and animals, Alberta); Rubtsov, 1963: 531 (citation); Fallis, 1964:445 (feeding on horses); Jenkins, 1964:25 (reference to predators); Vulcano, 1967:7 (catalog, distribution); Travis, Lee and Labadan, 1969: 124 (biology); Shemanchuk and Depner, 1971:82 (trapping); Tipton and Saunders, 1971:11 (Utah); Hall, 1974:65 (California); Jones and Akey, 1977:374 (citation); Barnard, 1979:854 (in car top trap); Lacey and Mulla, 1979:88 (fig. 2, recovery rate); Chance and Craig, 1986:1297 (citation); Braimah, 1987a:504 (larval filter feeding); Braimah, 1987b:514 (larval filter feeding); Braimah, 1987c:2395 (larval feeding behavior); Smith and Rapp, 1987:136 (first record in Nebraska); Burger, 1987:138 (biology); Currie and Craig, 1988:159 (larva, fig. 3); Francy et al., 1988: 345 (possible vector of Vesicular Stomatitis virus New Jersey serotype); Service, 1988:196 (trapping); Pruess, 1989:433 (larval colonization on artificial substrates); Kramer et al., 1990:487 (harboring Vesicular Stomatitis virus New Jersey serotype). Crosskey, 1990:148 (citation).
- Simulium (Simulium) bivittatum*, Peterson and Wolfe, 1958:564 (Canada).
- Simulium (Neosimulium) bivittatum*, Rubtsov, 1940:130 (assigned to subgenus *Neosimulium*).
- Simulium (Lanea) bivittatum*, Vargas, Martínez Palacios and Díaz Nájera, 1946:138 (compared with *S. (L.) zempoalense* V., M.P. and D.N.); Wirth and Stone, 1956: 405 (♀, ♂, pupa, key, California);
- Simulium (Psilopelmia) bivittatum*, Vargas and Díaz Nájera, 1958:13 (♀, ♂, pupa, key, pupal and larval descriptions, figs. 1–16, notes); Anderson and Voskuil, 1963:127 (feeding on farm animals, California); Stone, 1965:186 (catalog, distribution); Abdelnur, 1968:125 (♀, ♂, pupa, larva, keys, Alberta); Cole, 1969:110 (brief description, distribution, biting); Díaz Nájera, 1969:31 (citation); Depner, 1971:1150 (biology, Alberta); Peterson, 1981:369 (♀, ♂, figs. 42, 62, generic and subgeneric key); Fredeen, 1985:15 (♀, ♂, pupa, keys, fig. 23, map 16); Shipp, 1985:1826 (biology, Alberta); Currie, 1986:41 (pupa, larva, keys, biology, figs. 111, 139, 178); Corkum and Currie, 1987:207 (biology immature stages); Coscarón, 1987:30 (list, distribution); Pruess and Peterson, 1987:530 (biology, distribution, Nebraska); Crosskey, 1988:466 (world list, distribution); Duque, Muñoz de Hoyos and Rothfels, 1988: 300 (citation).
- Eusimulium clarum* Dyar and Shannon, 1927:21 (♀, ♂, key, original description, figs. 38, 52–53); Lectotype ♂ (here designated) and 2 paralectotype ♂♂, Type #28336 (USNM). Hearle, 1932:9 (description, biology, British Columbia) (misidentification); Stains and Knowlton, 1943:266 (♀, ♂, key, description, figs. 27, 34–35, 55–56); Fitch, Swenson and Tillotson, 1946:216 (misidentification, feeding on nestling red-tailed hawks); Knowlton and Fronk, 1950:5 (Utah); Travis, Lee and Labadan, 1969:115 (biological notes).
- Simulium (Eusimulium) clarum*, Rubtsov, 1940:121 (citation); Peterson and Wolfe, 1958:564 (valid species, Canada).
- Simulium clarum*, Smart, 1945:503 (catalog, valid species); Vargas, 1945c:126 (cat-



- alog, valid species, synonymy, distribution); Peterson, 1955:114 (syn. of *S. bivittatum*, Utah); Fallis, 1964:446 (feeding on long eared owl). Crosskey, 1990:415 (citation, but identity uncertain).
- Simulium (Lanea) clarum*, Vargas and Díaz Nájera, 1951a:149 (valid species).
- Simulium (Psilopelmia) clarum*, Stone, 1965:186 (catalog, syn. of *S. bivittatum*; California); Cole, 1969:110 (syn. of *S. bivittatum*); Crosskey, 1988:466 (syn. of *S. bivittatum*).
- Simulium meridionale* Malloch, 1914:49 (*clarum* in part; nec Riley, 1887) (apud Dyar and Shannon, 1927).
- Simulium (Simulium) idahoense* Twinn, 1938:50 (♂, original description, fig. 3a, b); holotype ♂, Type #4449 (CNC). Vargas, 1945a:77 (citation, ♂ syn. of *S. bivittatum*).
- Simulium idahoense*, Stains and Knowlton, 1943:278 (syn. of *S. bivittatum*); Smart, 1945:502 (catalog, syn. of *S. bivittatum*); Vargas, 1945c:120 (syn. of *S. bivittatum*).
- Simulium (Lanea) idahoense*, Vargas and Díaz Nájera, 1951a:149 (syn. of *S. (L.) bivittatum*).
- Simulium (Psilopelmia) idahoense*, Vargas and Díaz Nájera, 1958:13 (syn. of *S. bivittatum*); Stone, 1965:186 (syn. of *S. bivittatum*); Cole, 1969:110 (syn. of *S. bivittatum*); Crosskey, 1988:466 (syn. of *S. bivittatum*).

FEMALE. General body color bright yellow to yellowish orange, to brownish orange. Length: body, 2.3–3.3 (av 2.8) mm; wing, 2.2–2.7 (av 2.4) mm.

Head dark brown to black, densely silvery white pruinose on frons and clypeus, less dense on occiput. Frons moderately broad, at vertex about $\frac{2}{3}$ as wide as at narrowest point, less than $\frac{1}{2}$ width of head, and slightly wider than long; moderately covered with relatively long, decumbent, pale yellow pile. Clypeus concolorous or slightly lighter than frons; slightly longer than wide; moderately covered with relatively long, ventromedially directed pale yellow pile. Occiput densely covered with long, pale yellow pile; postocular setae pale, closely bent over eye margin. Scape and pedicel of antenna pale yellow to yellowish orange, usually concolorous or slightly lighter than flagellum which varies from pale yellow to brown; basal flagellomere slightly but distinctly longer than pedicel; fine pubescence pale yellow. Mandible with about 32–38 serrations. Blade of maxilla with 24–32 retrorse teeth. Palpus pale brown, palpomere 3 darkest; with pale yellow setae admixed with some brownish setae; palpomere 5 about $\frac{1}{3}$ longer than palpomere 3. Sensory vesicle about $\frac{1}{2}$ as long as its segment, proximally situated, its neck very short, arising middorsally and extended vertically, with a round mouth. Median proximal space of cibarium shallow, broadly U-shaped, with a shallow median depression and 2 sublateral lobes each bearing a series of short but usually conspicuous, stout seta-like denticles that sometimes extend

← Figs. 1–10. *Simulium bivittatum*. 1. Head of ♀. 2. Palpus of ♀. 3. Female sensory organ, enlarged. 4. Proximal end of ♀ cibarium showing armature. 5. Female thorax, dorsal view. 6. Hind, mid-, and fore legs of ♀. 7. Claw of ♀. 8. Male thorax, dorsal view. 9. Male terminalia: a. ventral view; b. lateral view; c. terminal (end) view; d. lateral view of gonostylus; e. inner view of left gonostylus. 10. Female terminalia: a. ventral view; b. lateral view. Abbreviations: an lb, anal lobe; cerc, cercus; gen fk, genital fork; goncx, gonocoxite; gonst, gonostylus; hyp vlv, hypogynial valve; m scl, median sclerite of aedeagus; pm, paramere; spmth, spermatheca; v plt, ventral plate of aedeagus.

part way across median depression; dorsolateral arm short, rather broad, heavily sclerotized.

Thorax pale grayish yellow to yellowish orange laterally and brownish yellow to brownish orange dorsally. Postpronotum pale yellow to yellowish orange, distinctly paler than scutum, sometimes pruinosity of thoracic vittae extends onto all or part of postpronotal lobe; covered with moderately long, semi-erect to erect, pale yellow pile. Scutum with 7 alternating stripes, median and sublateral stripes of yellowish to brownish orange ground color, median stripe reaching anterior margin, sublateral stripe extended to base of postpronotal lobe; median stripe ending posteriorly at anterior edge of posterior declivity; sublateral stripe extended to near anterolateral angle of scutellum; submedian and lateral stripes bright silvery white pruinose, submedian stripe united with pruinose posterior declivity, lateral stripes usually extended to hind margin of notopleural ridge but sometimes extended to, and united with, posterior declivity; pollinose stripes anteriorly sometimes extended, in varying densities, over all or portions of postpronotal lobes essentially surrounding dark sublateral stripes; scutum moderately covered with short, recumbent, pale yellow (golden yellow in some views) pile which is longer along lateral margin and still longer and semi-erect to erect posteromedially. Scutellum yellow to yellowish orange; densely covered with long, pale yellow setae. Postnotum brownish black to black, with a light silvery white pruinosity, and often with a faint to distinct, narrow, median yellowish basal spot or longitudinal line. Pleuron usually pale grayish yellow but sometimes brownish orange, moderately pruinose; katapisternum usually brown to brownish black, sometimes mottled with yellow or rarely entirely yellow or orange; anepisternal membrane pale grayish yellow, lightly pruinose; mesepimeral tuft small, pale yellow.

Wing membrane hyaline; veins yellowish; base of costa and stem vein with pale yellow setae, rest of setae on veins pale yellow, spinules black; fringe of calypter and anal lobe pale yellow. Halter pale yellow, with pale pile.

Legs: Foreleg yellow to orange yellow, base of first tarsomere sometimes yellow otherwise all tarsi brown to black, slightly swollen. Midleg with coxa yellowish brown to brown, femur, tibia and basal $\frac{3}{4}$ of 1st tarsomere and basal half of 2nd tarsomere yellow, rest of tarsomeres brown to black. Hind leg with coxa yellowish brown to brown, femur yellow, browned on about apical $\frac{1}{4}$, tibia yellow, browned on apical $\frac{1}{4}$ to $\frac{1}{3}$, 1st tarsomere yellow, brown on about apical $\frac{1}{4}$, 2nd tarsomere yellow on basal $\frac{1}{2}$ (including pedisulcus), remainder and apical tarsomeres brown to black; hind basitarsus about 5 or 6 times as long as broad; calcipala small, inconspicuous; pedisulcus small, inconspicuous, but deep. Claw simple, evenly but not strongly curved from base.

Abdomen largely grayish yellow, sometimes more brownish orange, terminal segments dorsally and pleural membranes more grayish; basal scale (tergite 1) pale yellow, with a fringe of long pale yellow pile; tergites 2–6 dark matte brown, these slightly increased in size posteriorly; pleural membrane of segments 3 and 4 each with an irregular dark mark; abdomen moderately covered with mostly short, recumbent, pale yellow pile; sternites 1–7 weakly sclerotized, often difficult to discern, sparsely covered with short, pale setae; sternite 8 more heavily sclerotized, dark brown, with long, mostly yellow setae interspersed with some dark brown setae.

Terminalia as in Figure 10. Anal lobe broad dorsally, slightly broadened ventrally to just below ventral margin of cercus where there is a varying prominent bulge at its posterior edge, then tapers obliquely anteriorly to a moderately long, slender,

fingerlike process that is about $\frac{1}{3}$ as long as total height of anal lobe; anal lobe moderately setose, digitiform process covered with short, fine setae. Cercus prominent, subrectangular, slightly higher than long, hind margin strongly rounded, moderately setose. Hypogynial valve rather short, not extended to anterior margin of cercus, each valve with a short median lobe that is bare and weakly sclerotized and often difficult to see, medial margins of lobes diverge obliquely, and sparsely microsetose basally. Stem of genital fork long, heavily sclerotized, about 3 times longer than arms; arm short, weakly sclerotized, with a prominent rounded lobe at inner distal corner, and a narrow, heavily sclerotized ridge along proximal margin and with a long, slender toothlike process at inner proximal angle; arm narrowly attached to segment 9. Spermatheca subglobular, heavily sclerotized, with a faint reticulate pattern.

MALE: General body color velvety brown to black, thorax dorsally variously marked with yellow or orange. Length: body, 2.4–3.0 mm; wing, 1.8–2.1 mm.

Clypeus densely grayish pruinose. Occiput, lower marginal area between eyes, and frons with long, brownish or black setae; clypeus with erect, yellow pile. Scape, pedicel and basal half of first flagellomere yellow, rest of antenna brown to black; first flagellomere slightly longer and more narrow than pedicel; fine pubescence pale yellow. Palpomere 3 black, 4 and 5 grayish brown, all with black pile; palpomere 5 slightly less than 3 times longer than palpomere 3. Sensory vesicle small, globular, about $\frac{1}{6}$ to $\frac{1}{4}$ as long as its segment; neck short, indistinct, with a small round mouth.

Prescutum black. Postpronotum yellow, concolorous with anterolateral corner of scutum, with long, pale yellow pile. Scutum varying from entirely black to reddish brown, and with varying amounts of yellow or orange; usually black with anterolateral corner yellow and a central black portion that reaches anterior margin, lateral margin and most of notopleuron rather broadly yellow and grayish pruinose, extended to near base of wing; posterior declivity varying from all black and densely grayish pruinose to having varying amounts of orange or yellow to being entirely yellow roughly in an M-shape; scutum when viewed from in front, with an outwardly curved, bright grayish pruinose mark originating at posterior edge of anterolateral yellow area of scutum and extended posteriorly to about half distance to base of wing; scutum densely covered with recumbent, golden yellow pile that is longer anteriorly and laterally, posterior declivity with long, erect to semi-erect yellow pile some of which is directed anteriorly. Scutellum varying from yellow to dark yellowish brown, distinctly paler than scutum; densely covered with long, yellow setae. Postnotum brownish black, grayish pruinose, contrastingly lighter than velvet black of scutum. Pleuron black, mesepimeron mottled with yellow below wing base and behind mid-coxa; anepisternal membrane yellow to brown; mesepimeral tuft yellow.

Wing membrane hyaline, veins pale yellowish; base of costa and stem vein with yellow pile, rest of setae on veins black; fringe of calypter and anal lobe yellow. Halter pale yellow with yellow pile.

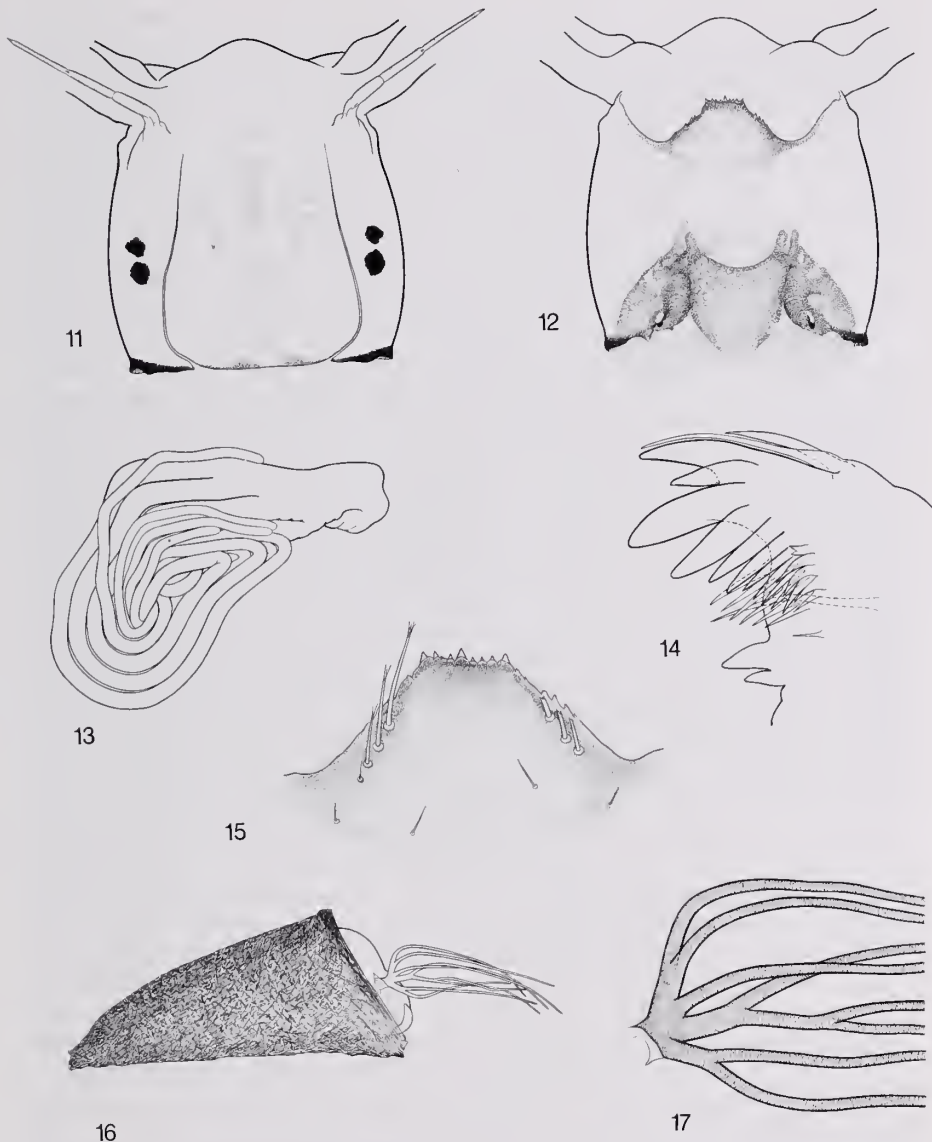
Legs, especially hind leg, somewhat variable in color. Foreleg usually yellow except for black tarsus, sometimes coxa, trochanter and dorsal surface of femur and tibia brownish and apex of tibia with a narrow brown ring. Midfemur, tibia, basal $\frac{3}{4}$ of basitarsus and basal half of second tarsomere yellow, remaining portions brown to black. Hind leg usually with basal $\frac{4}{5}$ of femur, basal $\frac{1}{2}$ of tibia, basal $\frac{3}{4}$ of basitarsus, and basal $\frac{1}{2}$ of second tarsomere yellow, remainder of segments black, sometimes hind femur entirely black. Yellow portions of all tibiae with a dense grayish pruinosity;

all yellow portions of legs with yellow setae and dark portions with black setae; hind femur and tibia with some long, black setae along posterodorsal margin; when hind femur entirely black it is variably covered with black and yellow setae. Hind basitarsus not swollen, about 5 times as long as broad, calcipala short, extended about $\frac{1}{3}$ distance to pedisulcus; pedisulcus deep but not conspicuous. Claw short and slender.

Abdomen with tergites black and remaining portion largely grayish yellow; basal scale with a fringe of long, pale yellow pile; tergite 2 with a narrow central black portion and lateral portion yellowish with a dense grayish pruinosity; tergites 3–5 and 9 velvety; tergite 6 varying from having same color pattern as tergite 2 to being entirely black but in all cases entirely densely grayish pruinose; tergites 7–8 velvety dorsally and densely pruinose laterally, pruinosity of tergite 8 confined to lateral edges; tergite 10 small, rectangular, about $\frac{2}{3}$ broader than long; dark portions of tergites with mostly short, black setae and occasionally with a few longer pale yellow setae intermixed; yellow and pruinose portions of tergites and pleural membrane with longer, yellow setae. Sternites 2–3 weakly sclerotized, pale yellow; anterior portions of sternites 4–8 brown to black, posterior portions yellow, with a few short black setae.

Terminalia as in Figure 9. Gonocoxite subconical, tapered distally, greatest width and length nearly equal, sparsely setose on distal half. Gonostylus subquadrate, short, only slightly longer than greatest width at base, sparsely covered with long setae, apical margin with outer distal corner rounded and inner distal corner produced as a short, narrowly rounded process bearing 1 small spine. Ventral plate of aedeagus broadly rectangular, about $\frac{1}{4}$ broader than long; in ventral view, body widest at junction with basal arms, tapered distally, apical margin nearly straight to slightly rounded but may have medial portion nearly straight, basal arm straight to slightly bowed, short, body and basal arms nearly equal in length, proximal margin between arms broadly concave; ventral plate, in lateral view, with short ventral lip whose ventral face is nearly straight; ventral surface densely covered with short setae. Median sclerite of aedeagus short, stem slightly longer than arms; arms short and imperfectly separated, distal margin of each arm oblique with a narrow, sclerotized ridge. Aedeagal membrane densely covered with minute, pale, irregular, ridgelike cuticular thickenings arranged in vaguely comblike series, these clearly visible only at magnifications of about $200\times$ or more; when viewed at $400\times$ they appear to consist of a series of minute setulae. Basal plate of endoparameral organ where it attaches to inner margin of outer corner of gonocoxite, subrectangular and bearing a series of conspicuous sclerotized, ridgelike thickenings (appearing corrugated or similar to a leaf with strong veins); arm about $2\frac{1}{2}$ times as long as basal plate, bent medially at about a right-angle from basal plate and extended internally for a short distance and then curved posteriorly at nearly another right-angle so that arms of both parameres approach medially and run parallel distal to median sclerite of aedeagus; arm of paramere composed of 20 or more poorly defined and irregularly sized teeth and teethlike corrugations.

PUPA. Length 2.2–3.6 (av 2.7) mm. Respiratory organ (gill) (Fig. 17) 1.7–2.2 (av 1.9) mm long, usually distinctly shorter than pupa; consisting of a short, rather slender base covered with minute spicules, and 8 filaments arranged in 3 groups whose branching pattern is somewhat variable but usually as follows: a ventral group of 2 filaments on a long petiole, a dorsal group branching (2+1) (dorsal-ventral) on a



K. Daisley

Figs. 11–17. *Simulium bivittatum*. 11. Head capsule of larva, dorsal view. 12. Head capsule of larva, ventral view. 13. Respiratory histoblast of mature larva. 14. Tip of mandible of larva. 15. Hypostoma of larva. 16. Cocoon and pupa, lateral view. 17. Basal portion of respiratory organ (gill) of pupa.

short petiole, and a mediolateral group branching (1+2) (d-v) on a petiole subequal to ventral group; filaments varying from yellowish brown to whitish gray, slender, with numerous shallow annulations. Integument of head and thorax with numerous, raised granules, these slightly larger and coarser than in *griseum*; antennal sheath of male reaching about $\frac{1}{2}$ distance to hind margin of head; antennal sheath of female just short of reaching hind margin of head by about length of apical antennomere; clypeus with a long, fine, pale, simple or bifurcate, submedian seta just ventral and medial to base of each antenna. Dorsum of thorax with 4–8 long, slender, simple or bifurcate trichomes that are pale and often difficult to see; usually 2 long, slender, pale, simple or bifurcate setae just anterior to base of wing sheath and with 1 similar seta slightly more dorsal near base of respiratory organ. Chaetotaxy of each lateral half of tergites as follows: abdominal tergite 1 with 2–5 short, pale whitish lateral setae; tergite 2 with 4 short, simple, hooklike setae and 1 more lateral and 1 more anterolateral setae, and with a small patch of minute spinules anterolateral to these setae; tergites 3 and 4 each with 4 stout, anteriorly directed spines along posterior margin and with 1 small seta anterior to hooks and 3–5 setae lateral to hooks; tergite 5 bare except for a very small patch of minute spinules anterolaterally; tergite 6 with several small series of minute, comblike spinules that merge laterally with an anterolateral patch of more minute spinules, numbers of spinules of both types variable; tergites 7–9 each with a row of short, fine, posteriorly directed spinules near anterior margin, that of tergite 7 variably developed and with a broad gap medially, while those of tergites 8–9 complete, rows of spinules on latter 3 tergites continuous laterally with a variably sized patch of minute spinules; caudal spines small, straight, tips slightly convergent, each situated on a slightly swollen convexity. Chaetotaxy of each lateral half of sternites as follows: sternite 3 with a single, tiny submedian seta; sternite 4 with 1 small, slender, submedian hook and a tiny seta lateral and another anteromedian to it; sternites 5–7 each with 2 longer, rather slender, bifid to trifid hooks, those of 5 submedian and close together while lateral hooks of sternites 6–7 more widely separated but not lying in pleural membrane; sternites 8–9 bare. Cocoon slipper-shaped, densely woven, anterior margin narrowly but distinctly thickened; in lateral view, anterolateral margin of cocoon nearly straight vertically or slightly slanting so that anteroventral corner of cocoon extends only slightly in front of dorsal margin, floor well developed and extended anteriorly about $\frac{1}{2}$ length of cocoon.

LARVA. Length 3.72–4.92 (av 4.42) mm. Body color grayish white marked with patches of darker gray dorsally on abdominal segments and nerve cord ventrally; dorsal intersegmental lines rather broad, slightly paler than rest of abdomen. Head capsule (Figs. 11, 12) varying from pale yellow to brown with an underlying yellow tinge; pale form (probably due to length of time from previous molt) with mandibular phragma and postoccipt brown, and variably brown on upper area of gena near eye spots and ventrally on hypostomal bridge; darker form with head capsule more uniformly brown and head spots distinctly yellow; anteromedian and posteromedian dorsal head spots rather widely separated; anterolateral spots 1 and 2 small, less distinct and more narrowly separated; posterolateral spot 1 small, slightly darker and separated from posterolateral spot 2 which is larger, yellow anterolaterally and darkened posteriorly and medially; frontoclypeal apotome anterior to head spots pale yellow only to about level of base of stalk of labral fan and then variably brownish medially to anterior margin and with anterolateral margins pale yellow, sometimes entire area anterior to head spots pale yellow; eye spots small and dark, area sur-

rounding them and extended from mandibular phragma to postocciput pale yellow. Antenna slightly longer than stalk of labral fan; basal 2 antennomeres faintly brownish dorsally, pale whitish and transparent ventrally; antennomere 3 slightly darker grayish brown except base which is narrowly white; proportions of antennomeres about 5:8:8 (basal to apical). Labral fan with about 30–45 primary rays. Hypostoma as in Figure 15; apical margin nearly straight to slightly concave, median tooth and outer lateral teeth nearly equal in length; usually with 4 sublateral teeth 1 of which is very tiny; and with 3 long and 1 short hypostomal setae along lateral margin, and a sublateral pair of setae posteriorly. Hypostomal cleft deep, extended about $\frac{1}{2}$ distance to base of hypostoma, broadly rounded to slightly pointed apically, length slightly more than greatest width. Hypostomal bridge slightly but distinctly longer than hypostoma. Mandible with 4–5 apical teeth of varying sizes and an erect toothlike process that diverges at about 90° from near base of apical teeth, this process slender and toothlike in some views and fanlike in other views; with about 7 comb teeth; subapical ridge with 2 fine, closely placed, distal serrations, distalmost serration longest. Maxillary palpus nearly parallel sided, 3.0–3.5 times as long as width at base. Lateral plate of proleg broad, a somewhat irregular rectangular to subquadrate or an inverted boot-shape, lightly sclerotized and difficult to see, extended about $\frac{3}{4}$, or slightly more, length of apical segment; circlet of apical hooks placed in about 28+ rows. Anal setulae very small and requires high magnification ($100\times$ or more) to see, sparse, and scattered laterally between arms of anal sclerite and between this sclerite and posterior circlet of hooks; anal papillae consisting of 3 simple (sometimes weakly compound) lobes, outer lobes separated at base from that of median lobe and with a small convexity situated between each lateral and median lobe, lateral lobes diverging from median lobe; abdomen with 2 small, barely noticeable, ventral tubercles. Arms of anal sclerite broadly joined medially, anterodorsal arm broad and pointed apically, slightly shorter and not as heavily sclerotized as posteroventral arm; posteroventral arm slender and tapered to a fine point apically. Posterior circlet of hooks consisting of about 12–17 hooks in 70+ rows.

REMARKS: Some tergites of the pupa have anterolateral patches, of variable size, of very minute spinules. A vague roughness in this area can be seen with a dissecting scope but the spinules are better seen under a compound microscope. The pupae I have examined of *S. griseum* do not have these patches of minute spinules, although more specimens than were available to me should be studied to test if this is a consistent character difference.

Dyar and Shannon (1927) described *Eusimulium clarum* from 15 specimens including the four females and three males they considered to be the type series. They described the female first and likened it to both *Eusimulium johannseni* (Hart) and their own *E. minus*, which was probably the reason that they described *clarum* as a species of *Eusimulium*. Fortunately, Dyar and Shannon designated the three males as the 'types' (cotypes), and the four females as paratypes. The males definitely are *bivittatum* and thus *clarum* can be clearly synonymized with *bivittatum*. Because I cannot locate any of the female paratypes, I cannot say if they are the same or a different species, or if they belong to *Eusimulium* or some other supraspecific group. Stone labelled, in pencil, the following slide mounted male as lectotype but, to my knowledge, never published this designation. This specimen, here designated as the lectotype of *clarum*, has the following data: Fresno, California, May 12, 1923, M. E. Phillips. The terminalia are clearly evident.

Simulium idahoense was described by Twinn (1938) on the basis of 33 male specimens. The holotype was, "... taken at light, ..." Riverdale, Idaho, September 2 (as II.IX, 1934), by C. F. Smith, and the 31 paratypes were from the same locality but collected on various dates ranging from late August to September, 1934, by C. F. Smith and G. F. Knowlton. One paratype was taken at Preston, Idaho, September 13, 1934, by C. F. Smith. Twinn noted that this species, "... may prove to be the undescribed male form of *S. bivittatum* Malloch, ..." Stains and Knowlton (1943) synonymized this species with *bivittatum* based on a long series of females from the type locality, and other specimens of both sexes that were taken together. Smart (1945) accepted this synonymy as did the other authors listed in the synonymical list above. The holotype male is mounted on a slide, with the body and wings under one coverslip, and the genitalia under another. Both gonocoxites and gonostyli are easily seen, but the aedeagal-parameral complex is squashed and obscured. The ventral plate is flattened and overlain by the also flattened parameres and consequently all the parts are not fully visible. However, after examining the type and 11 pinned paratypes, I can confirm the synonymy of *idahoense* with *bivittatum*.

SPECIMENS EXAMINED (total—1,240 males; 2,586 females; 125 pupae and pupal pelts; 1,703 larvae): ARIZONA: *Coconino Co.*, June 29, (A). CALIFORNIA: *Fresno Co.*, May 12–24, (A) (includes lectotype and paralectotypes of *clarum*). *Inyo Co.*, July 9–September, (A). *Kern Co.*, June 29–July 29, (A). *Riverside Co.*, May 25–August, (A). *Sacramento Co.*, August 21, (A). *San Bernardino Co.*, April (A). *Tulare Co.*, June 9–July 1, (A). COLORADO: *Adams Co.*, August 1, (A). *Boulder Co.*, August 23–October 23, (A). *Larimer Co.*, May 24–November 1 (A) (includes paratypes). *Mesa Co.*, July 29–August 13 (A). *Pueblo Co.*, July, (A). *Weld Co.*, March 21–October 15, (A). IDAHO: *Bannock Co.*, July 22–September 15, (A). *Elmore Co.*, August 9, (A). *Franklin Co.*, August 24–September 15, (A) (includes paratypes of *idahoense*). *Jefferson Co.*, July 29, (A). *Madison Co.*, July 19–20, (A). *Nez Perce Co.*, May 11, (A). *Twinn Falls Co.*, June 23–August 6, (A). MONTANA: *Cascade Co.*, July 7, (A). *Yellowstone Co.*, June 22, (A). NEBRASKA: *Blaine Co.*, 27, (P, L). *Brown Co.*, May 13–October 10, (A, P, L). *Cherry Co.*, May 27, (L). *Franklin Co.*, May 9, (L). *Gage Co.*, June 20, (P). *Keith Co.*, May 11–17, (A, P, L). *Lincoln Co.*, May 17–August 11, (A, L). *Loup Co.*, May 13–November 11, (A, P, L). *Nemaha Co.*, August 30, (L). *Saunders Co.*, August 13, (L). *Scotts Bluff Co.*, August 15, (L). *Sioux Co.*, May 22–June 9, (A). *Webster Co.*, March 22–August 30, (A, P, L). NEW MEXICO: *Catron Co.*, June 24, (A). *Colfax Co.*, July 1–4, (A). *Grant Co.*, June 24, (A,P). *Lincoln Co.*, May 7, (P, L). *Mora Co.*, August 17, (A,P). *Rio Arriba Co.*, July 12, (L). *Sandoval Co.*, July 4, (A). *San Miguel Co.*, August 16–19, (A) (includes paratypes). *Sierra Co.*, October 20, (A, P). *Taos Co.*, July 6, (A). OREGON: *Malheur Co.*, August 7, (A). SOUTH DAKOTA: *Lawrence Co.*, July 28, (A). TEXAS: *Collin Co.*, March 28, (A). *Menard Co.*, May 22, (A). UTAH: *Beaver Co.*, August 4, (A). *Box Elder Co.*, July 16, (A). *Cache Co.*, August 14, (A). *Garfield Co.*, July 3, (L). *Kane Co.*, July 18, (P, L). *Morgan Co.*, July 14–September 23, (A). *Salt Lake Co.*, August 1, (A). *Summit Co.*, July 1–August 14, (A, P, L). *Wasatch Co.*, July 17–August 25 (A). *Washington Co.*, June 22, (A). *Weber Co.*, July 28–September 9, (A). WASHINGTON: *Garfield Co.*, September 23, (A). *Kittitas Co.*, July 22, (A). *Yakima Co.*, May 19–August 17, (A). WYOMING: *Carbon Co.*, 1986, (A). *Niobrara Co.*, July 21–August 22, (A). *Park Co.*, August 22, (A). *Platte Co.*, August 18, (A). *Sweetwater Co.*, July 7–25, (A).

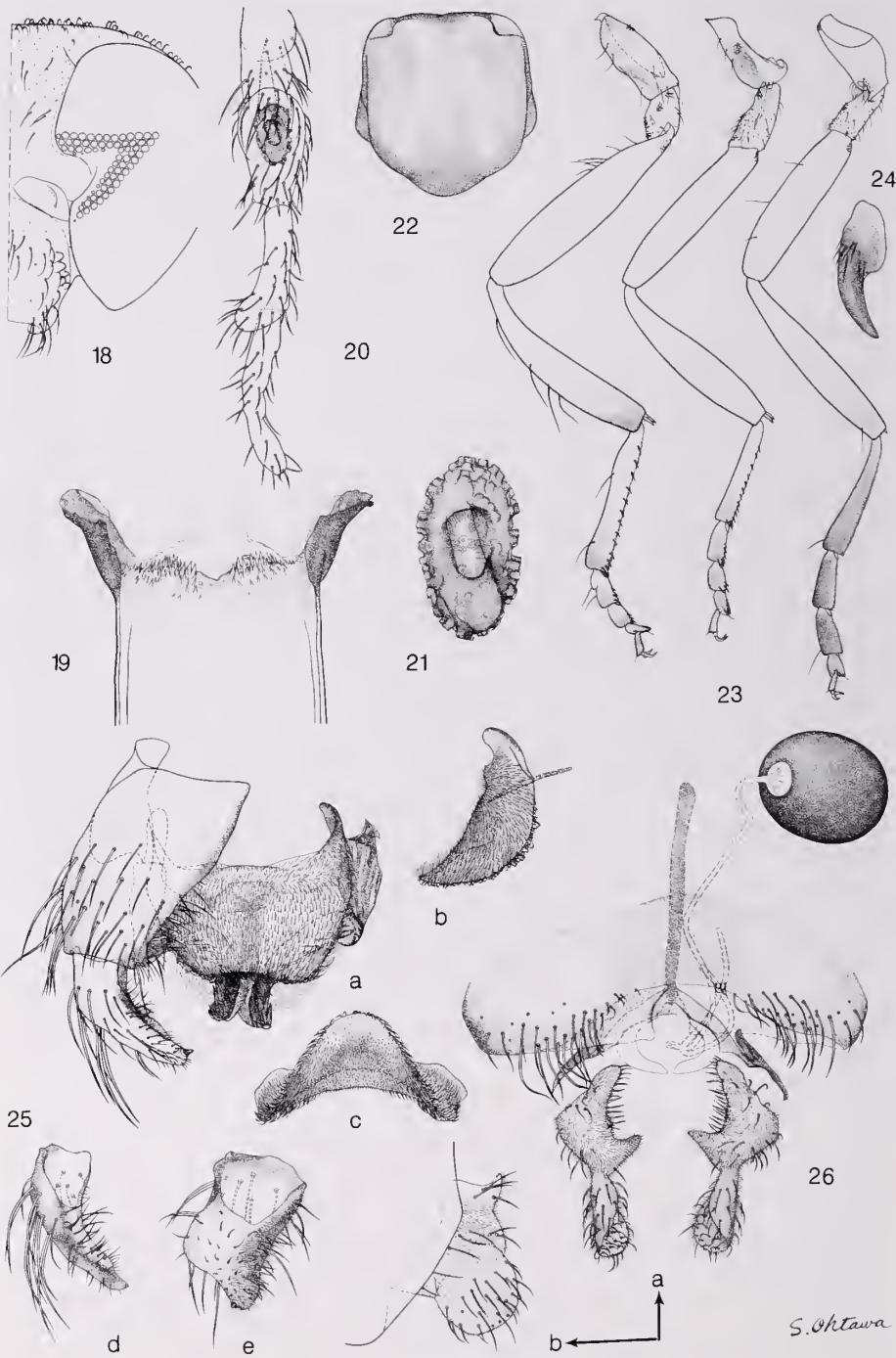
PREVIOUS RECORDS: CANADA: Alberta, Saskatchewan. U.S.: Arizona, California, Colorado, Idaho, Nebraska, Nevada, New Mexico, Montana, Oregon, South Dakota, Texas, Utah, Washington, Wyoming. MEXICO: Zacatecas.

BIOLOGICAL NOTES: The immature stages of *S. bivittatum*, like most North American species of *Psilopelmia*, are common in clean, warm to cool, relatively stable streams where they most frequently are found on trailing vegetation (Pruess and Peterson, 1987; Pruess, 1989). However, they have been collected by the author from submerged branches, rocks and trailing pieces of rope in southern Alberta and Utah. The immature stages also occur in irrigation ditches and other 'milky' type streams and rivers, but I have not found them to be nearly as numerous in such habitats. Aspects of filter feeding by the larvae have been discussed by Braimah (1987a, b, c). I have examined numerous adults, of both sexes, collected in light traps set up by Wayne Kramer in pasture areas and near barns in eastern Colorado. The females are pests of horses and cattle throughout the low foothill and prairie areas of the western states and western Canada. There are reports of females biting horses and other farm animals (Knowlton, 1935; Twinn, 1938; MacNay, 1958b, c, 1959a, 1961c, 1962; Anderson and Voskuil, 1963; Fallis, 1964), and mixed populations of *S. bivittatum* and *S. griseum* biting horses, cattle and man (Fredeen and Shemanchuk, 1960; Fredeen, 1981). There are specimens in the USNM collection labeled as biting horses and cows from California, Nevada, Utah and Wyoming. This species also has been reported as feeding on, or annoying man (Cole and Lovett, 1921; Essig, 1938; MacNay, 1962; Cole, 1969). There are even records of this species (as *Eusimulium clarum*) feeding on nestling red-tailed hawks (*Buteo jamaicensis* (Gmelin)) (Fitch et al., 1946; Fallis, 1964), and on the head of a young long-eared owl (*Asio wilsonianus* (Lesson)) (Hearle, 1932; Fallis, 1964). I am unable to confirm these bird feeding records and suspect they are based upon misidentified specimens. Francy et al. (1988) mentioned the presence of *S. bivittatum* among voucher specimens taken in Colorado, that were in a collection of species that formed a pool of several species that tested positive for Vesicular Stomatitis virus. Kramer et al. (1990) also reported the presence of Vesicular Stomatitis New Jersey virus in females of *S. bivittatum* in eastern Utah and western Colorado. This species apparently overwinters in the egg stage over most, if not all, of its range. However, the overwintering period may be much shorter in the extreme southern and drier parts of its range. Some other aspects of the biology of this multivoltine species have been discussed by Peterson (1959), Depner (1971), Lacey and Mulla (1979), Shipp (1985), Burger (1987), Currie (1986), Corkum and Currie (1987), Pruess and Peterson (1987), and Pruess (1989).

Simulium (Psilopelmia) griseum Coquillett

Figs. 18–33, 122–125

Simulium griseum Coquillett, 1898:69 (♂, ♀, original description in key); Holotype ♂, 3 ♀ paratypes, Type #10381 (USNM). Johannsen, 1903:361 (♂, ♀, description, list, key); Aldrich, 1905:168 (catalog); Emery, 1914 (as 1913):348 (list, key); Malloch, 1914:52 (♂, ♀, key, catalog); Knab, 1915b:78 (♂, ♀, compared with *mediovitatum* Knab); Dyar and Shannon, 1927:35 (♂, ♀, description, key, distribution, figs. 90–91, 94–96); Enderlein, 1930:96 (citation); Stains and Knowlton, 1943:278 (♂,



♀, description, key, distribution, figs. 83–84, 118–119, 128); MacNay, 1944:93 (citation); Smart, 1945:505 (catalog); Vargas, 1945c:141 (catalog, synonymy, distribution); Strickland, 1946:158 (Alberta); Knowlton and Fronk, 1950:5 (Utah); MacNay, 1952:333 (Alberta; irritating to man and livestock); MacNay, 1953:37 (Alberta); Edmunds, 1954:65 (biology, Nebraska); MacNay, 1954:156 (Saskatoon); Peterson, 1955:114 (Utah); Fredeen, 1956:4 (Alberta, Saskatchewan); Lindquist and Knipling, 1957:190 (biology, Nebraska); Fredeen, 1958:820 (Alberta, Saskatchewan); MacNay, 1958a:244 (attacking horses, Saskatoon); Peterson, 1958:153 (Utah); Bacon and McCauley, Jr., 1959:108 (citation); Fredeen, 1959:82 (citation); MacNay, 1959a:41 (Saskatoon, annoying horses); MacNay, 1959c:187 (Saskatoon, annoying horses); MacNay, 1959d:289 (Saskatoon, annoying horses); Fredeen and Shemanchuk, 1960:730 (biology, Alberta); Jones, 1961:114 (in bait traps, Colorado); MacNay, 1961a:290 (Saskatoon, annoying man and animals); MacNay, 1961c:305 (Saskatoon, annoying man and animals); Ryckman, 1961:405 (feeding on jackrabbits, California); Fredeen, 1964:109 (biology); Travis, Lee and Labadan, 1969:128 (citation, biology); Newell, 1970:47 (Montana); Hannay and Bond, 1971a:543 (wing surface structure); Shemanchuk and Depner, 1971:32 (citation); Tipton and Saunders, 1971:11 (Utah); Fredeen, 1973:5 (biting humans and animals, Alberta, Saskatchewan); Hall, 1974:65 (citation, California); Fredeen, 1977:224 (biology, Alberta); Jones et al., 1977:443 (biting horses); Smith and Rapp, 1987:136 (Nebraska); Burger, 1988:138 (citation).

Simulium (Simulium) griseum, Peterson and Wolfe, 1958:564 (Canada).

Simulium (Neosimulium) griseum, Rubtsov, 1940:130 (assigned to subgenus *Neosimulium*).

Simulium (Lanea) griseum, Vargas, Martínez Palacios and Díaz Nájera, 1946:107 (citation); Vargas and Díaz Nájera, 1951a:149 (citation); Wirth and Stone, 1956:405 (♂, ♀, key, California).

Simulium (Psilopelmia) griseum, Peterson, 1960b:100 (♂, ♀, pupa, keys, types, type locality, distribution, Utah); Stone, 1965:187 (catalog, distribution); Abdelnur, 1968:125 (♂, ♀, pupa, larva, key, Alberta); Cole, 1969:110 (citation, distribution); Depner, 1971:1151 (biology, Alberta); Fredeen, 1985:15 (♂, ♀, pupa, keys, fig. 23, map 17, Saskatchewan); Shipp, 1985:1826 (distribution, Alberta); Currie, 1986:42 (larva, pupa, keys, biology, distribution, fig. 178, Alberta); Corkum and Currie, 1987:207 (biology of immature stages); Pruess and Peterson, 1987:530 (biology, distribution, Nebraska); Crosskey 1988:466 (list, distribution); Duque, Muñoz de Hoyos and Rothfels, 1988:300 (citation).

FEMALE. General body color yellowish gray, to grayish brown, to grayish black, rather densely pruinose. Length: body, 1.8–3.3 (av 2.6) mm; wing, 2.2–2.6 (av 2.4) mm.

Head black. Frons broad, at vertex about $\frac{1}{4}$ wider than at narrowest point, slightly

←

Figs. 18–26. *Simulium griseum*. 18. Head of ♀. 19. Proximal end of ♀ cibarium showing armature. 20. Palpus of ♀. 21. Female sensory organ, enlarged. 22. Female thorax, dorsal view. 23. Hind, mid-, and fore legs of ♀. 24. Claw of ♀. 25. Male terminalia. 26. Female terminalia.

less than $\frac{1}{2}$ width of head, and about as wide as long; moderately covered with decumbent, whitish to pale yellow pile. Clypeus concolorous with frons; slightly longer than wide; with relatively long, whitish to pale yellow pile. Occiput densely covered with long, whitish to pale yellow pile that in some lights appears golden; postocular setae pale. Scape and pedicel of antenna pale yellowish orange, basal $\frac{1}{2}$ or less of first flagellomere often pale yellow, remainder of flagellum dark brown to black; pedicel and first flagellomere subequal in length; fine pubescence pale yellow. Mandible with about 31–39 serrations. Blade of maxilla with 26–28 retrorse teeth. Palpus dark brown to black, distal 2 segments slightly lighter than palpomere 3; with pale yellow setae admixed with some brownish setae; palpomere 5 about 2 times as long as palpomere 3, palpomeres 3 and 4 nearly equal in length. Sensory vesicle slightly more than $\frac{1}{2}$ as long as its segment, proximally situated, its neck very short, arising mediodorsally and extended vertically, with an enlarged round mouth. Median proximal space of cibarium moderately deep, broadly U-shaped, with a small median notch and two short lobes each bearing about 7 or more relatively large, irregular denticles and with a series of setalike denticles that extends about half way up inner margins of each arm, median notch often with several faint denticlelike undulations; dorsolateral arm moderately long, rather broad, heavily sclerotized.

Thorax with lobes of prescutum and postpronotum pale grayish yellow, distinctly paler than scutum; covered with long, semi-erect to erect, pale yellow pile. Scutum in dried specimens varying from uniformly yellowish gray to black with a dense grayish pruinosity, to having a faint pale median stripe and with a bright pruinose spot at anterolateral corner of scutum medial to postpronotal lobe; in alcohol preserved specimens scutum with a black pattern as in Figure 22; median dark stripe narrow at anterior margin of scutum between bright yellowish spots, this stripe broadened posteriorly, extended to posterior declivity, hind margin slightly emarginate at middle; a broad lateral black stripe on each side extended from bright yellow spot anteriorly to anterolateral angle of scutellum; lateral margin of scutum and notopleural ridge yellow providing a border extended around lateral and hind margins of scutum. Scutum covered with moderately dense, short, recumbent, whitish to pale yellow pile that sometimes has a faint golden sheen, and which is longer along lateral margin and still longer posteromedially. Scutellum slightly paler than scutum, with a faint pruinosity; densely covered with long, semi erect to erect yellowish setae. Postnotum brownish black to black, with a faint pruinosity. Pleuron yellowish brown to brownish black anteriorly, becoming slightly more pale posteriorly; anepisternal membrane slightly more pale than rest of pleuron; mesepimeral tuft small, pale yellow.

Wing membrane hyaline; veins yellowish. Base of costa and stem vein with pale yellow pile; fringe of calypter and anal lobe pale yellow. Stem of halter pale yellow, knob more whitish, with pale pile.

Legs: Foreleg entirely yellow, with yellow pile, except tarsus which is brown to black with both pale yellow and dark brown setae; tarsomeres only slight swollen. Midleg entirely yellow with yellow pile, except coxa with dark brown markings especially on posterior surface, and tips of tarsomeres 1 and 2, and sometimes 3 that are variously brown, sometimes tarsomere 3 entirely brown concolorous with apical 2 tarsomeres; tarsomeres with pale yellow setae on yellow areas and brown setae on dark areas. Hind coxa brown, sometimes mottled with yellow; femur and tibia largely

yellow except browned on apical $\frac{1}{3}$ or less; basitarsus yellow, browned on apical $\frac{1}{3}$ or less, 2nd tarsomere yellow on basal $\frac{1}{2}$, including pedisulcus, rest of tarsomeres brown; hind basitarsus about 7.5 times as long as broad; hind leg with pale yellow setae and some brown setae usually on dark portions of tarsus, posterior margin of hind tibia and basitarsus with 1 to 4 longer bicolored setae; calcipala small; pedisulcus small but deep and conspicuous. Claw short, simple, evenly curved from base; base pale yellow, remainder black.

Abdomen grayish yellow to yellowish brownish, basal scale (tergite 1) pale yellow, sometimes faintly mottled with brown, with a fringe of long, pale yellow pile; tergites 2–6 sclerotized, matte brown, 3 and 4 slightly larger than other tergites, tergites 7–10 yellow to brownish yellow, subshining; abdomen sparsely covered with short, pale setae except for some scattered short, brown setae on pleural membrane especially on dark pleural markings; pleural membrane of segment 4 and usually of segment 5, and sometimes of segments 3 and 6, marked with an irregular, ventrally elongate, dark spot, that of segment 4 largest; sternites 1–7 weak, hardly discernible; sternite 8 heavily sclerotized, especially on posterior $\frac{1}{2}$ which is dark brown and moderately covered with long, dark brown setae. Terminalia as in Figure 26. Anal lobe narrow dorsally, broadened ventrally, subrectangular below level of cercus, with posterior margin produced beneath cercus as a short, pale conical setose lobe, anteroventral margin tapered ventrally to a moderately long, slender, digitiform process that is $\frac{1}{4}$ longer than height of cercus; posteroventral marginal area rather densely setose, anteroventral area moderately heavily sclerotized, sparsely setose. Cercus subrectangular, about $\frac{1}{4}$ higher than long, hind margin strongly rounded, moderately setose. Hypogynial valve short, not reaching to anterior margin of cercus, subtruncate posteriorly, medial margin diverging from that of other side, faintly sclerotized, bare except lightly microsetose proximally. Stem of genital fork long, heavily sclerotized, about 2.3 times as long as arms; arm moderately long, posteromedial corner produced as a large medially directed, lightly sclerotized lobe with a blunt tip, anterior margin of arm with a heavily sclerotized ridge bearing a short, internal toothlike process; arm narrowly attached to segment 9. Spermatheca subglobular, heavily sclerotized, with a faint reticulate pattern.

MALE: General body color black, thorax densely grayish pruinose. Length: body, 2.1–3.2 (av 2.7) mm; wing, 1.6–2.0 (av 1.8) mm.

Frons, clypeus and occiput with long, erect, yellow pile. Antenna with scape, pedicel and basal half or less of first flagellomere yellow, remaining flagellomeres black; first flagellomere and pedicel nearly equal in length; fine pubescence pale yellow. Palpomere 3 black, palpomeres 4–5 paler yellowish brown, all with black pile; palpomere 5 2.2–2.5 times longer than palpomere 3. Sensory vesicle about $\frac{1}{2}$ as long as its segment; neck hardly discernible, with a small round mouth.

Postpronotum varying from grayish yellow to black, with pale yellow pile. Scutum usually entirely black and densely grayish pruinose, in anterior view with a short, bright, silvery pruinose spot just medial and posterior to postpronotal lobe, this spot sometimes appearing black in rubbed or greasy specimens, and not or only faintly visible in posterior view; sometimes lateral margin and notopleuron paler brownish to yellowish; scutum covered with short, recumbent, pale yellow pile that is longer along anterior and lateral margins and even longer posteromedially. Scutellum varying from yellowish brown to brown, densely covered with long pale yellow setae.

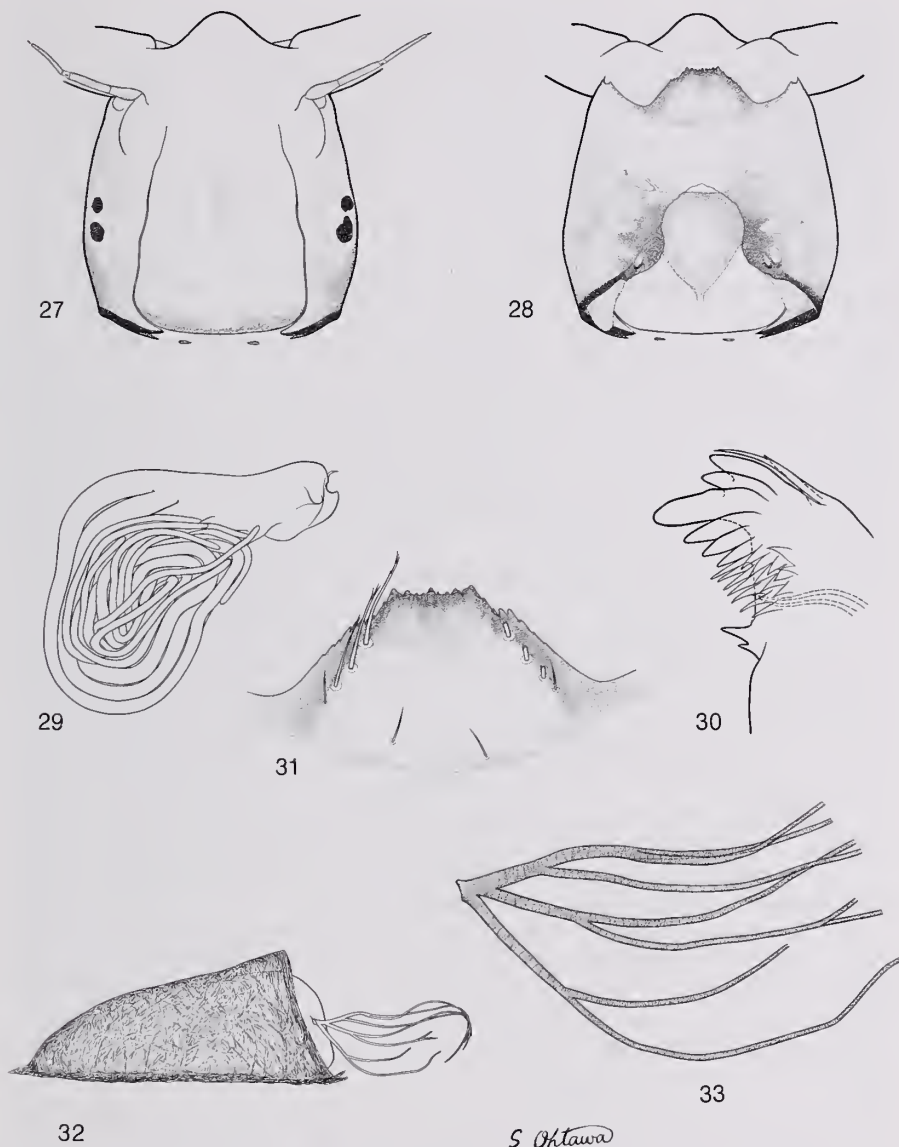
Postnotum usually concolorous with scutum but sometimes distinctly more brown, with a grayish pruinosity. Pleuron usually entirely black and densely grayish pruinose, sometimes mesepimeron slightly more brown and faintly mottled with yellowish; anepisternal membrane varying from yellow to black; mesepimeral tuft pale yellow.

Wing membrane hyaline; veins yellowish white; base of costa, stem vein and other veins with pale yellowish to whitish pile; fringe of calypter and anal lobe pale yellowish to whitish. Knob of of halter yellow, stem brownish at base, with pale yellowish pile.

Foreleg yellow except for tarsus which is black; with mostly yellow pile except black setae predominant on tarsomeres. Midleg yellow except for coxa and distal 2 or 3 tarsomeres which are black, 3rd tarsomere varying from having basal half yellow to all black; with mostly yellow setae except for black setae on dark areas. Hind leg yellow except coxa, usually distal $\frac{1}{3}$ or less of femur, distal $\frac{1}{3}$ – $\frac{1}{2}$ of tibia, apical $\frac{1}{4}$ of basitarsus and basal $\frac{1}{2}$ or slightly more of 2nd tarsomere which are black; femur sometimes showing considerable variation from being all yellow to all black, sometimes 3rd tarsomere with basal half yellow and sometimes all black; setae mostly yellow except for some black setae on dark portions of leg; hind basitarsus slender, varying from 5 to 8 times as long as broad, Calcipala short, not reaching pedisulcus; pedisulcus deep and relatively long.

Abdomen showing considerable variation in color with pinned specimens being mostly black while alcohol preserved specimens show more yellow especially laterally and ventrally; basal scale with dorsomedial portion yellow and lateral portions black, always with a fringe of long, pale yellowish to whitish pile; tergite 2, in alcohol preserved specimens, entirely yellow or with a small, black, central marking, in dried specimens this tergite densely grayish pruinose and strongly contrasting with following tergite; tergites 3–5 and 7 largely black; tergite 6 in alcohol preserved specimens yellow except for narrow, black, anterior margin, in dried specimens this tergite densely grayish pruinose strongly contrasting with preceding tergite; terminal tergites black, except lateral portions of 7 and extreme lateral margins of 8 densely grayish pruinose; sparsely covered with short, yellow pile which is longer laterally and on pleural membrane; tergite 10 small, subquadrate, about as long as broad, hind margin usually rounded; sternites pale yellow, sometimes tinged with varying amounts of black, with mostly pale yellow setae.

Terminalia as in Figure 26. Gonocoxite rectangular but tapering distally, about $\frac{1}{3}$ longer than greatest width, sparsely setose on distal $\frac{1}{2}$. Gonostylus short, rectangular, about twice as long as greatest width at base; broadly rounded on outside distal corner, slightly concave medially, and inner distal corner produced as a short, but prominent, triangular process bearing a single apical spine, this process somewhat accentuated by slight concavity of medial margin of gonostylus. Ventral plate of aedeagus broad, flattened, widest distal to junction with basal arms, greatest width slightly more than greatest length, distal margin broadly rounded, slightly peaked medially, proximal margin between basal arms arcuate, basal arm very short, pointed; in lateral view, with a short ventral lip, ventral face of which is concave; ventral surface densely covered with short setae. Median sclerite of aedeagus relatively broad, heavily sclerotized, tapered distally; arms short, imperfectly separated, distal margin of each arm obliquely rounded with a narrow sclerotized rim that forms a prominent, lateral process that extends outwardly beyond stem. Aedeagal membrane densely covered with a series of minute, irregular, comblike thickenings bearing minute

*S. Ottawa*

Figs. 27–33. *Simulium griseum*. 27. Head capsule of larva, dorsal view. 28. Head capsule of larva, ventral view. 29. Respiratory histoblast of mature larva. 30. Tip of mandible of larva. 31. Hypostoma of larva. 32. Cocoon and pupa, lateral view. 33. Basal portion of respiratory organ of pupa.

setulae. Plate of endoparameral organ subquadrate to somewhat conical, slightly tapered distally, with 1 strong and several weaker, ridgelike thickenings, arm bent medially at about a right-angle and then shortly bent posteriorly, bearing about 6–8 relatively well defined, moderately large, basal teeth plus about 8–12 smaller, weaker and ill defined teeth; parameral arms running subparallel posteromedially, tips of arms approaching each other distomedially.

PUPA. Length 2.5–3.4 (av 2.9) mm. Respiratory organ (Fig. 33) 1.8–2.3 (av 2.0) mm, shorter than pupa; consisting of a short, rather slender base covered with minute spicules, and with 8 filaments arranged in 2 main groups: a ventral group with 2 filaments, and a dorsal group that branches into 2 groups of 3 filaments each that branch (2+1) + (1+2) (dorsal, ventral); petiole of ventral pair of filaments slightly longer than subequal petioles of mediolateral and dorsal groups of filaments. Filaments yellowish to gray, slender, with narrow but distinct annulations. Integument of head and thorax with numerous distinctly raised granules resembling sandpaper; antennal sheath of male reaching only about $\frac{1}{2}$ distance to hind margin of head; antennal sheath of female short of reaching hind margin of head by about length of 1 antennomere; clypeus with a submedian pair of pale setae just below level of base of antenna. Thorax laterally with 3–6, slender, pale trichomes that are simple or bifurcate, these sometimes difficult to see; a row of 5–6 tiny setae present just anterior to wing and metathoracic leg sheaths and with a single, larger, more anterior seta. Chaetotaxy of each lateral half of abdominal tergites as follows: tergite 1 with 1–3 pale setae laterally; tergite 2 with 4 short, hooklike setae along posterior margin and with 2–3 tiny, more anterior setae; tergites 3 and 4 each with 4 anteriorly directed hooks along posterior margin and 4–5 scattered setae anterior and lateral to hooks; tergite 5 and usually 6 bare; tergites 8–9 each with a row of short, fine, posteriorly directed spinules near anterior margin, these occasionally present on tergites 6–7 but vary from 4–5 spines to (more rarely) a nearly complete row of spines but these are always weakly developed; caudal spines very short, situated on two faintly swollen convexities, straight, tips subparallel to slightly convergent. Chaetotaxy of each lateral $\frac{1}{2}$ of sternites as follows: sternite 3 bare; sternite 4 with 1 small, submedian, slender hook; sternites 5–7 each with 2 longer, rather slender hooks, those of 5 submedian and closer together, those of 6–7 more widely separated but lateralmost hooks not lying in pleural membrane; sternites 8–9 bare. Cocoon slipper-shaped, yellowish to grayish, densely woven, anterior margin narrowly but noticeably thickened; in lateral view, anterolateral margin of cocoon slightly concave but distinctly sloping forward so that about $\frac{1}{3}$ of total length extends in front of dorsal rim; floor of cocoon extends forward about $\frac{1}{2}$ length of cocoon.

LARVA. Length 3.7–4.2 (av 4.0) mm. Body color pale yellowish white to brownish yellow; often abdominal segments dorsally each with a sublateral gray spot on each side leaving a longitudinal white median stripe extended along first 5 or 6 segments, posterior segments sometimes continuously gray across segment, ventrally abdomen more pale except for gray nerve cord; intersegmental lines rather broad, often slightly lighter than rest of abdomen. Head capsule (Figs. 27, 28) essentially as in *bivittatum* with a similar head spot pattern except specimens available for study are distinctly paler and pattern more obscure than in *bivittatum*. Antenna nearly transparent, faintly yellowish; distinctly longer than stalk of labral fan; proportions of antennomeres (basal to apical) 11:13:13. Labral fan with about 30–36 primary rays. Hypostoma as

in Figure 31; distal margin of hypostoma nearly straight to slightly concave, median tooth usually faintly longer than outer lateral teeth, sublateral teeth all small and subequal in size, paralateral teeth and lateral serrations faintly indicated; with 3 longer and 1 shorter hypostomal setae on each side and 1 pair of posterior sublateral setae. Hypostomal cleft moderately deep, extended about $\frac{2}{3}$ distance to base of hypostoma, broadly rounded distally, about as wide as long. Hypostomal bridge subequal in length to hypostoma. Mandible with 4–5 apical teeth of varying sizes and a toothlike process set at about 90° to base of apical teeth, this process appearing shorter, broader and less sclerotized than that in *bivittatum*; with about 6 comb teeth; inner subapical ridge with 2 fine serrations, distalmost larger, proximal serration much smaller and often difficult to see. Maxillary palpus nearly parallel sided, about 3.5 times as long as width at base. Lateral plate of proleg broad, subquadrate, lightly sclerotized, extended about $\frac{3}{4}$ or more length of apical segment; circlet of apical hooks arranged in 20–28 rows. Anal setulae very small and difficult to discern, sparsely scattered laterally between arms of anal sclerite and between this sclerite and posterior circlet of hooks; anal papillae composed of 3 simple lobes, outer lobes arising next to base of median lobe and diverging laterally; abdomen with 2 small but noticeable ventral tubercles. Arms of anal sclerite broadly joined medially and often with a short, sclerotized lobelike projection anteriorly between anterodorsal arms; anterodorsal arm moderately broad, rather heavily sclerotized but not as strongly as posteroventral arm, about $\frac{1}{3}$ shorter than posteroventral arm which is slender and heavily sclerotized. Posterior circlet of hooks consisting of about 11 hooks in about 60 rows.

REMARKS: Coquillett (1898) named *Simulium griseum* with no description other than that given in a key to the species of the United States. He separated the females out at couplet 8 of his key (based on three specimens), and mentioned they were from Colorado, but he made no mention of the male at this point. In couplet 10 of his key he separated out the male, and indicated that it was taken with the females mentioned above. Coquillett did not designate a holotype, but the single male in the collection bears a type label presumably placed there by Coquillett. The head, thorax, legs and wings of the holotype are glued to a paper point and pin mounted. The uppermost label on the pin is smaller than the lower labels and bears the data, "Colo. 1605." The next lower label is a red type label with "Type No. 10381 U.S.N.M." Below this is a yellow label with "Pseudotype," followed by a label with "slide" on it, and finally the bottom label carries the name "*Simulium griseum* Coq." The head of the type is shriveled, but complete; the scutum is spotted with grease marks but the anterior sublateral, pruinose, triangular patches are distinct and the remainder of the scutum clearly shows the overall extent of the pruinosity, demonstrating that it is not *bivittatum* or any of the other species treated here. The legs are complete, as is the left wing, but the right wing consists only of a narrow strip with the anterior veins, and the extreme base of the blade of the wing, the rest is missing. The abdomen of the type is mounted on a slide under a single coverslip. The slide is labeled "*Simulium griseum* Coq.," and in the same ink and handwriting, "Type δ ." No other data appear on the slide label. All parts of the terminalia are visible but quite flattened.

Although *griseum* is a relatively widespread species, often overlapping or even sharing the same habitats with *bivittatum*, it was not found in as large numbers as the latter species. I suspect that this species has been misidentified on numerous occasions, especially material preserved in alcohol. In dry, pinned females the dorsum

of the scutum is rather uniformly brownish gray, often with a tinge of yellowish or even greenish pruinosity, and without strong evidence of thoracic vittae. However, in fluid preserved specimens the scutum often shows strong dark marks, especially laterally and medially, with the median stripe usually shorter than lateral stripes, and rounded posteriorly. In this respect, it sometimes approaches *venator* and even *mediovittatum*, in thoracic similarity of fluid preserved specimens. The males of *griseum*, even those in alcohol, are more uniformly dark, with a marked grayish pruinosity on the scutum, while the scutum of *bivittatum* is much more matte black without the grayish pruinosity, and the lateral margins and notopleuron are usually tinged with distinct patches of yellow. From an anterodorsal view, the male scutum of *griseum* shows two sublateral, triangular spots anteriorly that are much smaller than those of *bivittatum*. This feature is usually evident in both dry and alcohol preserved material. However, at times, specimens show up that defy identification even using genital characters.

Also, see notes under *bivittatum* regarding the separation of these two species in the pupal stage.

SPECIMENS EXAMINED (total—998 males; 991 females; 108 pupae and pupal pelts; 379 larvae): ALBERTA (Canada): One Tree Creek, Brooks, August 6, 1958, F. J. H. Fredeen, (P, L). ARIZONA: *Coconino Co.*, May 26–October 6, (A). *Gila Co.*, August 22, (A). *Maricopa Co.*, April 9, (A). *Pinal Co.*, May 11, (A). *Santa Cruz Co.*, March 10, (A). *Yuma Co.*, April 6–8, (A). CALIFORNIA: *Imperial Co.*, April 7–June 11, (A). *Monterey Co.*, March 25, (A). *Riverside Co.*, April 30–June 12, (A). *San Bernardino Co.*, April 28–December 13, (A). *Tulare Co.*, June 9–July 1, (A). COLORADO: Colorado (no other data) (includes syntypes). *Adams Co.*, August 1, (A). *Boulder Co.*, no date, (A). *Crowley Co.*, August 14–20, (A). *La Plata Co.*, July 17, (A). *Larimer Co.*, June 2–September 19, (A). *Mesa Co.*, July 29–October 8, (A). *Pueblo Co.*, July 25, (A). *Weld Co.*, March 21–October 15, (A). NEBRASKA: *Lincoln Co.*, August 23, (A). *Scotts Bluff Co.*, September 8, (P, L). NEW MEXICO: *Bernalillo Co.*, April 30–August 2, (A). *Catron Co.*, October 20, (A). *Doña Ana Co.*, April 16–September 2, (A, P, L). *Grant Co.*, June 24–October 21, (A, L). *Guadalupe Co.*, June 7, (A, L). *Mora Co.*, August 17, (A). *Socorro Co.*, August 7, (A, P, L). *Taos Co.*, July 6, (A). NEVADA: *Clark Co.*, December 16, (A). SOUTH DAKOTA: *Fall River Co.*, Hot Springs, July 9–30 (A). UTAH: *Grand Co.*, August 21, (A). *Salt Lake Co.*, July 29–August 1, (A). *San Juan Co.*, August 30, (A). *Sevier Co.*, June 15, (A). *Wasatch Co.*, July 21, (A). *Washington Co.*, March 17–September 9, (A, P, L). *Wayne Co.*, May 18, (A). WYOMING: *Carbon Co.*, June 22, (A). *Converse Co.*, 1986, (A). *Platte Co.*, 1986, (A). *Sweetwater Co.*, July 13–17, (A). *Washakie Co.*, July 20, (A).

PREVIOUS RECORDS: CANADA: Alberta, Saskatchewan. U.S.: California, Colorado, Montana, Nebraska, New Mexico, Texas, Utah.

BIOLOGICAL NOTES: This small, multivoltine species is often collected in combination with *S. bivittatum*, and has essentially the same seasonal and geographic distribution. However, it does not seem to be nearly as abundant as *S. bivittatum* in the northern reaches of their ranges. Because the immature stages of the two species are so similar, it has been difficult for authors to be sure of the species with which they were dealing. *Simulium griseum* frequently accompanied *S. bivittatum* in the light trap collections mentioned in the discussion under the latter species, and nearly always was present in fewer numbers of both sexes. This species also is a pest of

horses (MacNay, 1958a, 1959a, c, d; Jones et al., 1977), and to a lesser extent cattle and man (MacNay, 1952, 1961a, b, c; Fredeen, 1958; Fredeen and Shemanchuk, 1960; Fredeen, 1973). There are specimens in the USNM collection labeled as taken from horses and steers. Ryckman (1961) observed that the ears of the jackrabbit, *Lepus californicus* Gray, were heavily bitten by *Simulium griseum* (and two species of Ceratopogonidae), during daylight hours in Imperial County, California. In the more northern reaches of the range of this species, it overwinters in the egg stage, while in the more southern parts of its range larvae can be found, in varying numbers, throughout most of the year. The immature stages often occur in greatest abundance in the warmer, slower flowing waters of small irrigation ditches. Edmunds (1954) reported it to occur in large numbers on cement drop structures of irrigation systems in Nebraska. Miscellaneous biological notes on this species can be found in the papers by Fredeen (1964, 1977), Depner (1971), and Currie (1986).

Simulium (Psilopelmia) mediovittatum Knab

Figs. 34–50, 126–132

Simulium mediovittatum Knab, 1915b:77 (♀, original description); holotype ♀, Type #19635 (USNM). Dyar and Shannon, 1927:37 (♀, description, key, distribution); Stains and Knowlton, 1943:279 (♂, ♀, key, distribution, figs. 85–86, 117, 127, 129); Smart, 1945:508 (catalog [as *meddiiovittatum*], distribution); Vargas, 1945c:159 (catalog, synonymy, distribution [one entry as *madiovittatum*]); Knowlton and Fronk, 1950:5 (Utah); Vargas and Díaz Nájera, 1954:69 (♀, pupa, larva, description, figs. 31–39, first record in Mexico); Peterson, 1955:114 (Utah); Peterson, 1959:151 (citation); Wiseman and Eads, 1960:45 (biting, distribution in Texas); Vulcano, 1967:16 (catalog, distribution); Field, 1969:284 (compared with *fuliginis* Field); Travis, Lee and Labadan, 1969:131 (citation); Newell, 1970:47 (Montana); Tipton and Saunders, 1971:11 (Utah); Travis, Vargas V. and Swartzwelder, 1974:190 (biting humans in Neotropical Region); Jones et al., 1977:443 (attacking horses). *Simulium (Neosimulium) mediovittatum*, Rubtsov, 1940:130 (assigned to subgenus *Neosimulium*).

Simulium (Lanea) mediovittatum, Vargas, Martínez Palacios and Díaz Nájera, 1946:107 (citation).

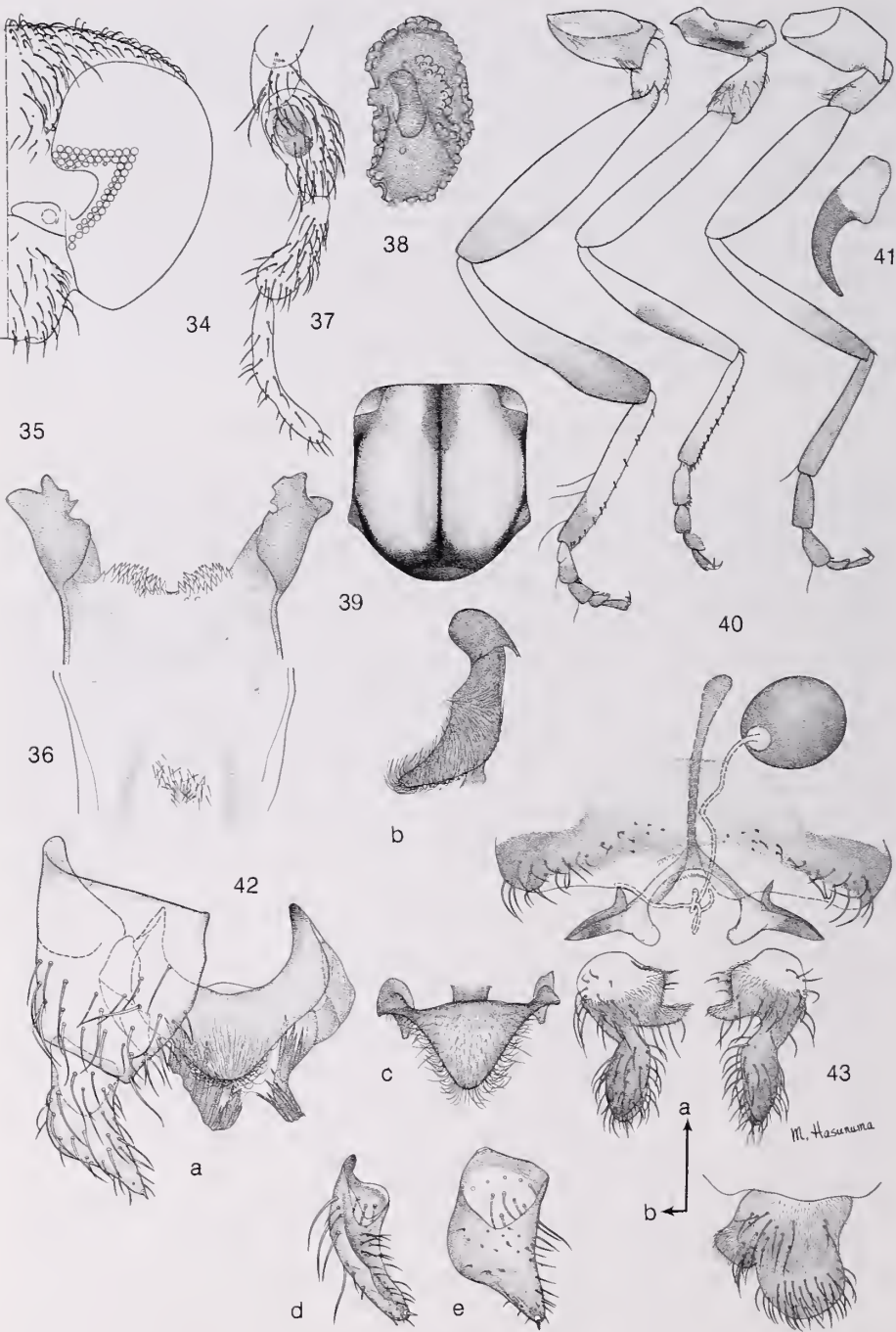
Simulium (Psilopelmia) mediovittatum, Vargas and Díaz Nájera, 1957:154 (♂, ♀, pupa, keys, figs. 343–349, distribution in Mexico); Vargas and Díaz Nájera, 1958:14 (♂, ♀, pupa, keys, Mexico); Peterson, 1960b:100 (♂, ♀, pupa, keys, type, type locality, distribution); Díaz Nájera and Vulcano, 1961:221 (citation); Stone, 1965:187 (catalog, distribution); Coscarón, 1987:31 (list distribution); Crosskey, 1988:466 (list, distribution). Crosskey and Lowry, 1990:220 (paratype in BM(NH)).

Simulium (Neosimulium) venator, Vargas, 1945c:159 (listed as synonym of *mediovittatum*); nec Dyar and Shannon, 1927; Rubtsov, 1940.

Simulium venator, Stains and Knowlton, 1943:279 (syn. of *mediovittatum*); Smart, 1945:508 (syn. of *meddiiovittatum* [sic]); Vargas, 1945c:159 (syn. of *mediovittatum*); nec Dyar and Shannon, 1927.

Simulium (Simulium) venator, Vargas, 1945c:159 (syn. of *mediovittatum*); nec Dyar and Shannon, 1927; Twinn, 1938.

FEMALE. General body color somewhat variable but usually brownish black with



a distinct underlying orange tinge. Length: body, 1.8–2.9 (av 2.5) mm; wing, 1.9–2.4 (av 2.2) mm.

Head brownish black to black, densely grayish pruinose. Frons broad, at vertex about $\frac{2}{3}$ as wide as at narrowest point, slightly less than $\frac{1}{2}$ width of head, width and length subequal; moderately covered with moderately long, whitish to pale yellow pile. Clypeus concolorous with frons; slightly longer than wide; moderately covered with moderately long, pale yellow pile. Occiput densely covered with long, pale yellow pile; postocular setae pale. Antenna with scape, pedicel and basal $\frac{1}{2}$ of first flagellomere yellow to orange, flagellum varying from entirely yellow, to orange and often tinged with brown, to brownish black; pedicel and first flagellomere subequal in length; fine pubescence pale yellow. Mandible with about 29–39 serrations, those of outer margin weak and varying in number from 4–12. Blade of maxilla with 23–28 retrorse teeth. Palpus brown to black, often with an underlying yellowish or orange tinge, and pale yellow setae; distal 2 segments often slightly lighter than palpomere 3; palpomere 5 about $\frac{1}{3}$ longer than palpomere 3, palpomere 4 slightly longer than 3. Sensory vesicle slightly more than $\frac{1}{2}$ as long as its segment, proximally situated, its neck short but distinct, arising middorsally and extended vertically, with an enlarged ovoid mouth. Median proximal space of cibarium shallow, broadly U-shaped, with 2 low lobes and a relatively broad median depression, lobes each bearing a series of fine, but variably distinct, setalike denticles that extend nearly to middle of median depression; dorsolateral arm shorter than in other related species, broad, heavily sclerotized.

Thorax rather variable in color ranging from yellowish orange to brownish black to black but with at least traces of an underlying orange tinge, and extensively gray pruinose. Antepronotum and postpronotum distinctly paler than scutum; covered with long, semi-erect to erect, pale yellow pile. Scutum showing considerable variation in colors noted above, and often a mottled combination of these colors, densely grayish pruinose except longitudinally along midline; anterolateral corner of scutum without a distinct white or grayish spot, but with a single median, moderately broad, distinct, non-pruinose stripe that varies from orange through brown to black, and extends from anterior margin of scutum to posterior declivity; lateral margin of scutum and notopleural ridge paler than dorsum; scutum sparsely covered with short, recumbent, pale yellow pile that is longer along lateral margin and posteromedially. Scutellum usually concolorous with basic dark color of scutum, but sometimes paler yellowish brown, orange brown, blackish brown or black; densely covered with long, pale yellow and a few brownish setae. Postnotum brownish black, with a dense grayish pruinosity. Pleuron yellowish to orange brown to brownish black and densely gray pruinose anteriorly, and sometimes mottled medially and posteriorly; anepisternal membrane concolorous with rest of pleuron, at most faintly paler; mesepimeral tuft small, pale yellow.

Wing membrane hyaline; veins yellowish. Base of costa and stem vein with pale

←
Figs. 34–43. *Simulium mediovittatum*. 34. Head of ♀. 35. Proximal end of ♀ cibarium showing armature. 36. Central portion of cibarium showing patch of microsetae. 37. Palpus of ♀. 38. Female sensory organ, enlarged. 39. Female thorax, dorsal view. 40. Hind, mid-, and fore legs of ♀. 41. Claw of ♀. 42. Male terminalia. 43. Female terminalia.

yellow pile; fringe of calypter and anal lobe pale yellow. Halter whitish to pale yellow, with pale setae.

Legs: Forecoxa yellow, faintly tinged with brownish; femur yellow but with varying portions brown; tibia yellow; tarsus dark brown, tarsomeres only slightly swollen. Midleg with coxa brown; femur, tibia and basal 4 tarsomeres yellow but femur and tibia variably ringed with brown dorsally on apical $\frac{1}{2}$, basal 4 tarsomeres variably tinged with brown but apical tarsomere entirely brown. Hind coxa brown; femur varying from all yellow variably marked with brown on dorsal surface to entirely brown; tibia yellow on about basal $\frac{1}{2}$, remainder dark brown; basitarsus yellow but brown on about apical $\frac{1}{4}$; basal $\frac{1}{2}$ of both second and third tarsomeres yellow, remainder brown; distal 2 tarsomeres brown; hind basitarsus about 7 times as long as broad; calcipala small but conspicuous; pedisulcus small but deep and conspicuous. Pile on legs mostly pale yellow with some scattered dark setae near apices of tibiae and on tarsi and some scattered brownish setae elsewhere on darkened portions of legs, long setae on posterior margins of tibiae and tarsi mixed pale and dark. Claw short and simple, evenly curved from base.

Abdomen yellowish gray to brownish black, basal scale (tergite 1) paler yellowish gray to yellowish brown, with a fringe of long pale yellow pile; tergites 2–6 matte brown, tergites 7–10 paler yellowish gray to yellowish brown; pleural membrane of segments 3–6 with elongate, ventrally directed, dark markings, that of segment 6 sometimes reduced; sternites 1–7 hardly discernible, sternite 8 heavily sclerotized, dark brown and with pale setae along posterior margin; abdomen mostly with short, pale yellow setae but with some scattered, short, brown setae on dark markings of pleural membrane, and posterior segments with a few longer dark setae.

Terminalia as in Figure 43. Anal lobe short, moderately setose; in lateral view, vaguely <-shaped, with each arm subequal in length and about as broad dorsally as ventrally, ventral arm noticeably more sclerotized than dorsal arm and in one view shows a short ventral convexity or lobelike process but without a conspicuous digitiform process; shortly produced posteriorly beneath cercus with posteroventral margin rather truncate and fringed with short, fine setae; in ventral view, anteroventral (inner distal) corner produced as a slight but distinct convexity or lobe, and posteroventral (inner proximal) corner acutely rounded. Cercus subquadrate, slightly higher than long, hind margin broadly rounded, moderately setose. Hypogynial valve nearly transparent and difficult to see except under high magnification; short, subtriangular, rather broadly rounded to slightly pointed posteromedially, with medial margin lightly sclerotized, rather straight or faintly concave; valves narrowly separated basally, divergent distally, sparsely microsetose on basal $\frac{1}{4}$ or less. Stem of genital fork heavily sclerotized, rather long, about twice as long as arms, and rather sinuous to strongly curved; in lateral view, rather strongly bent ventrally from point of origin of arms; arms moderately broad, divergent but space between them broadly rounded, inner posterior corner of arm rounded to broadly but shortly pointed, hind margin broadly but shallowly concave with anteroventral margin produced rimlike and posterodorsal (inner) margin with a sclerotized, toothlike process directed anteriorly and extended from point of origin about $\frac{1}{2}$ total length of arm; arm narrowly attached to segment 9. Spermatheca small, rounded, heavily sclerotized, apparently without a pattern, but with a small, round, membranous area at junction with spermathecal duct.

MALE. General body color black. Length: body, 1.92–3.0 (av 2.5) mm; wing, 1.6–2.0 (av 1.8) mm.

Medial marginal area between eyes, upper margin of frons, and clypeus with erect brownish yellow pile. Occiput with long, yellow and brownish yellow setae. Antenna dull yellow with a faint brownish tinge; first flagellomere and pedicel equal in length; fine pubescence pale yellow. Palpus brown, palpomere 3 slightly darker, with brownish yellow setae; palpomere 5 about twice as long as palpomere 3. Sensory vesicle small, about $\frac{1}{5}$ to $\frac{1}{4}$ as long as its segment; neck very short, with a small round mouth.

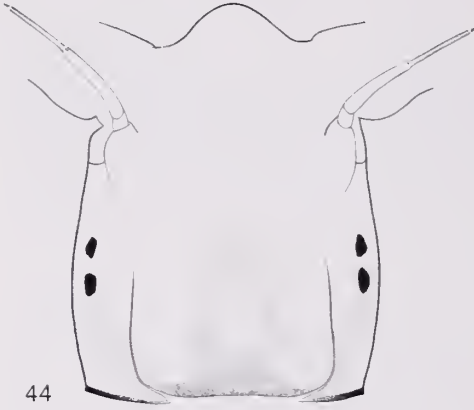
Prescutum pale brown; postpronotum slightly darker, and grayish pruinose; with pale yellow pile. Nonpruinose areas of scutum matte black, lateral margins and posterior declivity bright grayish to silvery pruinose; in anterior view, with a large, bright, grayish to silvery pruinose triangular mark just medial and posterior to postpronotal lobe, this mark strongly tapered medially along outside margin to a level just in front of base of wing and continues posteriorly as a slender stripe that unites with pruinosity of posterior declivity; covered with long, recumbent, pale yellow pile along anterior and lateral margins, and short, pale yellow setae on pruinose areas and coppery brown setae on black areas of scutum. Scutellum brown to black but paler than scutum; densely covered with long, pale yellow setae some of which may have dark bases. Postnotum concolorous with scutellum, lightly pruinose. Pleuron, including anepisternal membrane, nearly uniformly dark brown to black and densely grayish pruinose; mespimeral tuft small, of short, brownish yellow setae.

Wing membrane hyaline; veins whitish to faintly yellowish; base of costa, and stem vein with pale yellow setae some of which may have dark bases; fringe of calypter and anal lobe pale yellow. Knob of halter white, stem brown, with brownish yellow setae.

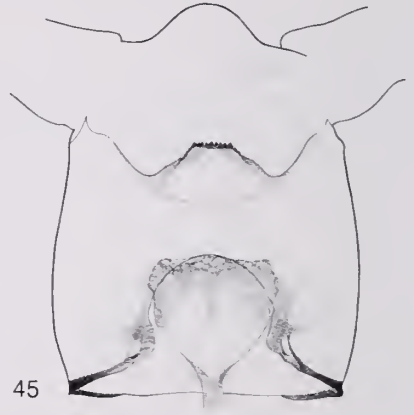
Foreleg mostly yellow except for coxa which is variously blackened, femur which is variously but lightly tinged with black, most of dorsal $\frac{1}{2}$ of tibia and all tarsomeres black. Midleg largely yellow except coxa, apical $\frac{1}{3}$ to $\frac{1}{2}$ of femur and tibia, and apical $\frac{1}{4}$ of basitarsus which are variously tinged with black, and tarsus which is all black. Hind leg largely black except for about basal $\frac{1}{3}$ of femur, basal $\frac{1}{2}$ of tibia, $\frac{1}{2}$ to $\frac{2}{3}$ of basitarsus, and basal $\frac{1}{2}$ of second tarsomere which are yellow; hind basitarsus slender, 5 to 6 times as long as broad; calcipala short, just reaching pedisulcus, rounded; pedisulcus small but moderately deep; legs with mostly yellow setae on yellow portions and mostly black setae on black portions.

Nonpruinose areas of abdominal tergites matte black; basal scale tinged with yellow, bearing a fringe of long yellow pile; tergites 2, 5, 7 and 8 each with a central black spot and densely grayish pruinose laterally; tergites 4 and 5 without pruinosity; tergite 6 entirely pruinose; tergites dorsally with short setae that appear pale yellow in some views and coppery brown in other views, laterally all tergites with long, pale yellow setae; tergite 10 small, rectangular, about 2.5 times as long as broad; pleural membrane gray, densely pruinose; sternites yellowish, densely pruinose, with mostly pale yellow setae.

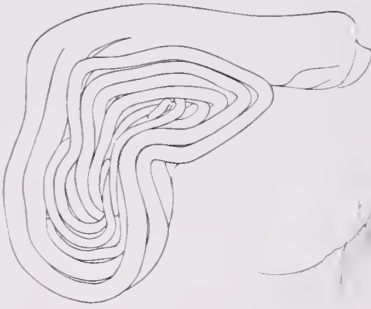
Terminalia as in Figure 42. Gonocoxite subrectangular, length and width nearly equal, tapered distally, sparsely covered with setae on about distal $\frac{1}{2}$, about $\frac{1}{4}$ longer than gonostylus. Gonostylus angularly subrectangular, greatest length about twice width at base; outer distal corner broadly rounded, obliquely continuous with inner



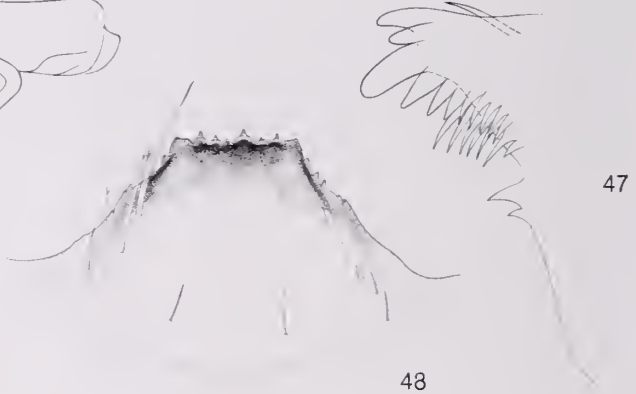
44



45

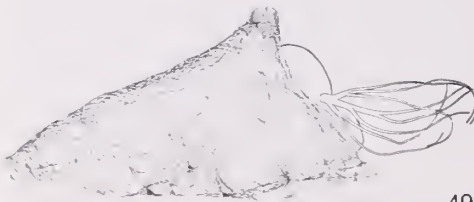


46

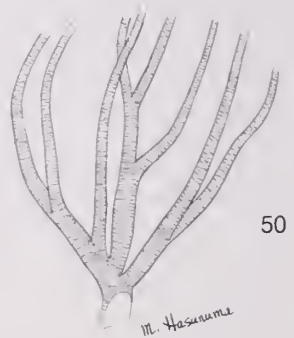


47

48



49



50

M. Hasunuma

Figs. 44–50. *Simulium mediovittatum*. 44. Head capsule of larva, dorsal view. 45. Head capsule of larva, ventral view. 46. Respiratory histoblast of mature larva. 47. Tip of mandible of larva. 48. Hypostoma of larva. 49. Cocoon and pupa, lateral view. 50. Basal portion of respiratory organ of pupa.

distal corner that is produced as a relatively long, triangular projection bearing a single terminal spine, this process considerably longer than in any of the other species treated in this work. Ventral plate of aedeagus, in ventral view, triangular, broadest just distal to junction of body and basal arms, lateral margins broadly rounded or sometimes lateral margins slightly concave near tip but tapered distally to a median point, proximal margin between basal arms usually strongly convex at middle but sometimes weakly concave, basal arm broad at junction with body but slightly curved inwardly and tapered distally to acute point, strongly sclerotized; in lateral view, with a short, but prominent, ventral lip; dorsal and ventral surfaces densely covered with moderately long setae; median sclerite of aedeagus with stem only slightly longer than arms, sclerotized, slender basally, widening distally; arms paler and poorly defined, expanded clublike, distal margin sclerotized but less so around gonopore; aedeagal membrane densely covered with closely placed comblike clumps of minute setulae. Basal plate of endoparameral organ slender, rectangular, with a series of ridgelike, cuticular thickenings; arm slender with 2–4 (usually 2) strong, well defined spines near base that are continuous with a distal cluster of 15 or more (about 15–24 but difficult to count) smaller, closely placed and less well defined spines among which may be 2–4 better defined spines that approach basal spines in size and development.

PUPA. Length 2.2–3.6 (av 2.6) mm. Respiratory organ (Fig. 50) 1.4–1.9 (av 1.6) mm, usually broken but apparently distinctly shorter than pupa; consisting of a short, rather slender base covered with minute spicules, and with 8 filaments arising in 3 groups branching (2+1) + (2+1) + (2) (d-v); dorsal group on a short petiole, mediolateral and ventral groups on longer, subequal petioles; in lateral view, filaments usually spread out so no branch obscures any other branch; filaments grayish to yellowish, rather smooth with only faint indications of fine, closely placed annulations. Integument of head and thorax moderately covered with slightly raised, rounded granules of rather uniform size; clypeus with a pair of submedian setae just anteroventral to bases of antennae, and with 2 setae along edge of frons just above base of antenna; antennal sheath of male reaching about $\frac{1}{2}$ distance to hind margin of head; antennal sheath of female short of reaching hind margin of head by about length of 2 distal antennomeres. Thorax with 4–9 dorsal trichomes on each side most of which are long, slender and pale, and simple or bifurcate, and with a single seta just anterior to base of metathoracic leg sheath, and another near base of wing sheath. Chaetotaxy of each lateral half of tergites as follows: tergite 1 with 2 short lateral setae; tergite 2 with 4 short hooklike setae and 2 more lateral setae; tergites 3 and 4 with 4 stout, anteriorly directed spines along posterior margin and with a single seta just anterior and another just lateral to lateralmost hook and a similar seta just medial to innermost hook; tergites 5–7 largely bare, except tergite 6 laterally with a small patch of very minute spinules, and tergite 7 with 3 or 4 slightly larger, posteriorly directed spinules laterally that merge with a patch of very minute spinules; tergites 8–9 each with a row of short, fine, posteriorly directed spinules near anterior margin, those of tergite 8 with only a few minute lateral spinules, while those of tergite 9 merge laterally with a larger patch of minute spinules; caudal spines short and straight, each situated on a slightly swollen convexity, tips slightly divergent. Chaetotaxy of each lateral half of sternites as follows: sternite 3 with 2 very small, submedian setae, and an irregular band (consisting of a number of rows) of very minute spinules traversing entire width of sternite; sternite 4 with 2 small, slender, lateral setalike

hooks and a band of very minute spinules placed in about 8 or more rows, this band enlarged patchlike laterally; sternite 5 with 2 closely placed submedian hooks and a small, lateral patch of minute spinules and 1 longer seta; sternites 6–7 each with 2 widely separated hooks, lateral hooks not lying in pleural membrane, and each sternite with a small patch of minute spinules just anterolateral to ventralmost hooks; sternite 8 with a transverse band of very minute spinules in about 5 or more rows; sternite 9 bare. Cocoon slipper-shaped, brownish yellow, tightly woven but sometimes it is thin and transparent and appears delicate, anterior margin thickened dorsally but sometimes thinning somewhat ventrally; in lateral view, with a low profile, antero-lateral margin projected in front of dorsal margin by about $\frac{1}{4}$ of total length; floor loosely woven, extended anteriorly about half length of cocoon.

LARVA. Length 3.9–5.8 (av 4.5) mm. Body color light brownish yellow, slightly darker posterodorsally, intersegmental lines narrow, only faintly paler than remainder of abdomen. Head capsule (Figs. 44, 45) pale yellow to pale brownish yellow, head spots usually obscure and difficult to discern; anteromedian spot small, posteromedian spot larger, both pale yellow, anteromedian spot sometimes partially surrounded while posteromedian spot is entirely surrounded by a slightly darker, narrow, brownish area, frontoclypeal apotome anterior to head spots varying from pale yellow to transparent whitish color; eye spots small. Antenna slightly but distinctly longer than stalk of labral fan; basal 2 antennomeres nearly colorless, third antennomere faintly brownish, basal antennomere about $\frac{2}{3}$ or slightly more, as long as other 2 antennomeres which are subequal in length, proportions of segments (basal to apical) 13:15:16. Labral fan with 50–60 (av 55) primary rays. Hypostoma as in Figure 48; anterior margin of hypostoma nearly straight, median, sublateral and outer lateral teeth all heavily sclerotized and nearly equal in size, 2 paralateral teeth slightly smaller and less sclerotized, lateral serrations distinct but small and weak; with 2 long anterolateral, 2 shorter posterolateral, and 1 pair of short, sublateral hypostomal setae along posterior margin. Hypostomal cleft broadly rounded, distal margin faint and rounded to slightly pointed medially, distinctly longer than wide; cleft moderately deep, extended about $\frac{2}{3}$ distance to base of hypostoma. Hypostomal bridge slightly shorter than hypostoma. Mandible with 6 apical teeth, about 8 combteeth, and inner subapical ridge with 2 fine serrations of which distalmost is largest, proximalmost somewhat variable in size but always smaller than distalmost serration. Maxillary palpus nearly parallel sided, tapered only slightly, about 3 times as long as width at base. Proleg with about 26–30 apical rows of hooklets; lateral plate of proleg broad, irregularly subquadrate, lightly sclerotized, extended most of length of apical segment. Anal setulae absent; anal gills simple, with 3 digitiform lobes, bases of lobes not contiguous, outer lobes divergent. Anterodorsal arm of anal sclerite moderately broad, tapered distally and rather pointed, moderately sclerotized with a heavily sclerotized ridge on inner margin, about $\frac{2}{3}$ as long as posteroventral arm which is longer, slender and heavily sclerotized; posteroventral arm with a faint, nonsclerotized, linelike indication extending around abdomen from one arm to the other; arms broadly joined medially. Posterior circlet of hooks consisting of about 14 hooks in 68–76 rows. Ventral tubercles small, not well developed.

REMARKS: *Simulium mediovittatum* looks very much like *venator* and the two have been confused by various authors as can be seen from the literature listed in the synonymy. Both are densely pruinose, but the former species generally is more brownish in overall basic coloration with the central stripe brown, while the latter

species is generally much blacker overall with a dark brown to black median stripe. The females of the two species are easily separated on the basis of the anal lobe which in *mediovittatum* is very short with, at most, a slight ventral convexity or lobelike process that often is only barely discernible. The anal lobe of *venator* is considerably longer and has a ventral digitiform process that approaches that of *bivittatum* and *griseum* in length and shape. The thoracic pattern of the males is quite distinctive in that the scutum of *mediovittatum* has two large, submedian, triangular spots that strongly taper posteriorly and continue as two very slender pruinose stripes that merge with the pruinosity of the posterior declivity of the scutum. In *venator* the thoracic pattern consists of two smaller submedian, anterior, pruinose, triangular spots that do not continue as stripes and do not merge with the pruinosity of the posterior declivity of the scutum. The pupa of *mediovittatum* is distinctive in that it is the only species of the group that has the gill filaments branching $(2+1) + (2+1) + (2)$. The larva is more difficult to characterize but can be distinguished by the features given in the key. Also, to my knowledge, this species is known only from Texas. Peterson's (1960b) record is undoubtedly based on a misidentification and possibly refers to *venator*. I have not seen specimens from Mexico and so can not verify its presence there.

The complete holotype female is mounted on a minuten pin on a block of soft wood attached to a regular insect pin. The pin extends upward at an angle between the fore and middle legs and emerges at the posterior corner of the scutum just at the wing base. The type female is in good condition but the right antenna is missing except for the scape, and the right corner of the scutum has a few grease spots. There are four labels on the pin. The label just below the specimen reads, "Bishopp No. 3938;" the next lower label reads, "Arlington X-28-14 TX;" the next to bottom label is a red USNM type label bearing the number "19635;" and the bottom label is the identification label, "*Simulium mediovittatum* Knab," apparently printed by Knab. The type resides in the collection of the U.S. National Museum, Washington, D.C.

SPECIMENS EXAMINED (total—110 males; 788 females; 1,801 pupae and pupal pelts; 1,482 larvae): TEXAS: *Bexar Co.*, April 3–June 21, (A). *Cameron Co.*, Oct. 16, (P, L). *Dimmit Co.*, June 21, (A). *Kerr Co.*, April 30–October 23, (A, P). *Kimble Co.*, May 8, (A, P). *Kinney Co.*, May 9–10, (A, P, L). *Maverick Co.*, July 17–September 12, (A). *Menard Co.*, February 16–October 9, (A, P, L). *Nueces Co.*, October 6–December 10, (A, P, L). *Pecos Co.*, January 24–October 17, (A). *Presidio Co.*, June 26–September 30, (A). *Real Co.*, May 11, (P, L). *Starr Co.*, April 26–December 15, (A, P, L). *Sutton Co.*, March 1, (A). *Tarrant Co.*, October 28, (A) (includes paratypes). *Terrell Co.*, June 10–October 14, (A). *Travis Co.*, July 16–October 17, (A, P, L). *Uvalde Co.*, April 21–May 11, (A, P, L). *Val Verde Co.*, May 9–October 13, (A, P, L). *Victoria Co.*, April 24, (A, P, L). *Zavala Co.*, June 21, (A).

PREVIOUS RECORDS: U.S.: Texas, Utah (misidentification). MEXICO: Chihuahua, San Luis Potosi, Tamaulipas, Veracruz.

BIOLOGICAL NOTES: This is a poorly known species and, to my knowledge, is unknown outside of Texas and northern Mexico, although I would not be surprised to see it in adjacent areas of extreme southern Arizona and New Mexico. The immature stages of this multivoltine species probably occur throughout most of the year, at least where the temperatures remain relatively high. They can be found largely on trailing vegetation, often in large numbers. Females have been reported to feed on horses and other farm animals (Stains and Knowlton, 1943; Wiseman and

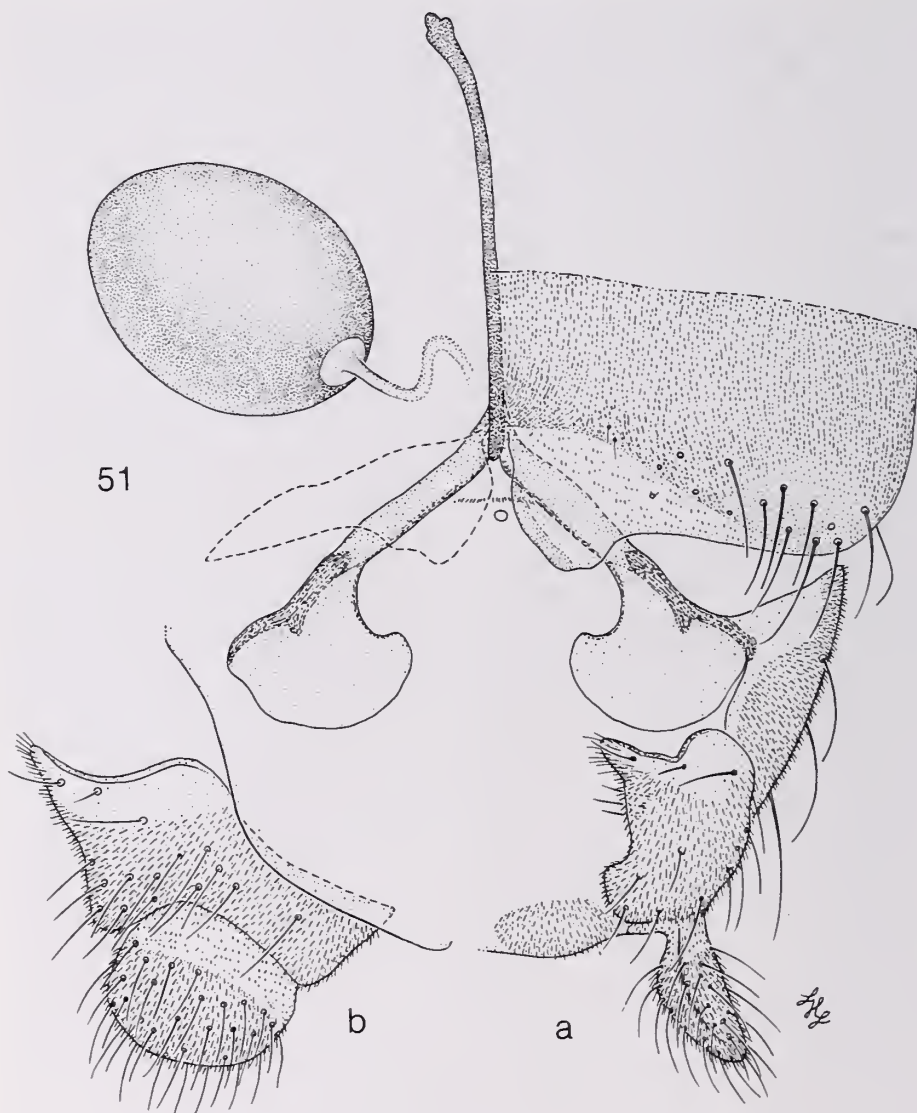


Fig. 51. *Simulium notatum*. 51. Female terminalia.

Eads, 1960; Jones et al., 1977), and humans (Travis et al., 1974). There are specimens in the USNM that were removed from burros, mules, ears of horses, and jackrabbits.

Simulium (Psilopelmia) notatum Adams

Fig. 51

Simulium notatum Adams, 1904:434 (♀, original description); Lectotype ♀ (here designated), 1 ♀ paralectotype (UKaL); Malloch, 1914:32 (♀, ♂, description, key,

catalog, plate 5, fig. 6) (misidentification, ♀ = *robynae* Peterson, n. sp.; ♂ identity unknown); Dyar and Shannon, 1927:36 (♀, ♂, description, key, figs. 88–89) (misidentification, ♀ = *robynae*; ♂ identity unknown); Enderlein, 1930:96 (citation); Essig, 1938:552 (on horses in New Mexico) (misidentification); Stains and Knowlton, 1943:278 (♀, description, distribution, key); Smart, 1945:510 (catalog, distribution); Vargas, 1945c:170 (catalog, synonymy, distribution); Pan Amer. Sanit. Bur., 1950:4 (literature reference); Wiseman and Eads, 1960:47 (wrongly recorded from Texas by Dyar and Shannon); Byers et al., 1962:164 (syntype depository); Travis, Lee and Labadan, 1969:132 (citation).

Simulium (Neosimulium) notatum, Rubtsov, 1940:130 (assigned to subgenus *Neosimulium*).

Simulium (Psilopelmia) notatum, Stone, 1965:187 (catalog, distribution); Cole, 1969:110 (citation, distribution); Crosskey, 1988:466 (list, distribution).

FEMALE. General body color yellowish orange, with a silvery white pruinosity. Length: body, 1.7 mm; wing, 1.8 mm.

Head dark brownish black, densely grayish white pruinose on occiput, frons and clypeus. Frons noticeably broad, at vertex slightly less than twice as wide as at narrowest point, slightly less than $\frac{1}{2}$ width of head, and about as wide as long; sparsely covered with moderately long, decumbent, almost white pile. Clypeus concolorous with frons; slightly longer than wide; sparsely covered with moderately long, ventromedially directed, pale yellow to whitish pile. Occiput densely covered with long, pale yellow to whitish pile; postocular setae pale. Antennomeres yellowish orange, fine pubescence pale yellow; pedicel and first flagellomere subequal in length. Mandible with about 21 serrations on inner margin and 3–4 faintly discernible (under high magnification) serrations on outside margin. Blade of maxilla with 15–17 retrorse teeth. Palpus entirely pale yellowish orange, distal 2 segments slightly lighter than palpomere 3; with pale yellow setae; palpomere 5 subequal in length to palpomere 3. Sensory vesicle elongate, basally situated, about $\frac{1}{2}$ as long as its segment, without a neck but with an anterodorsally directed, enlarged, ovoid mouth. Median proximal space of cibarium very shallow and broadly U-shaped, with a patch of about 12 setalike denticles on slight convexities on either side of a slight medial depression; dorsolateral arm short, rather broad, heavily sclerotized.

Thorax nearly uniformly yellowish orange, with a grayish white pruinosity that is more dense dorsally and on katapisternum; without any trace of stripes or markings on scutum in anterior and lateral views, but in posterior view, anterolateral corner of scutum with a small, grayish white pruinose spot [lectotype specimen pinned through middle of thorax so this area is obscured of any features that might be present]; scutum sparsely covered with short, recumbent, pale yellow pile which is longer along lateral and posterior margins and still longer posteromedially. Scutellum yellow, covered with long, pale yellow setae. Postnotum yellowish brown, with a dense pruinosity; anepisternal membrane slightly more pale yellow than rest of pleuron; mesepimeral tuft small, of pale yellow pile.

Wing membrane hyaline; veins yellowish. Base of costa and stem vein with pale yellow pile; rest of setae on veins pale yellow, spinules black; fringe of calypter and anal lobe pale yellow. Stem of halter yellowish orange, knob whitish, stem with short, pale pile.

Legs: Foreleg entirely yellow except for apical 4 tarsomeres that are brownish; foretarsus only slightly swollen. Midleg entirely yellow except apical 2 tarsomeres

brownish. Hind leg entirely yellow except extreme apical margin of tibia, including calcipala, and apical 2 tarsomeres brownish; hind basitarsus about 6 times as long as broad; calcipala hardly developed, brownish; pedisulcus small but distinct. Claw strongly curved from base, simple but base of claw slightly produced. Legs with pale yellow pile, some longer, erect, yellow setae present on posterior margins of tibiae and basitarsi.

Abdomen yellow, basal scale (tergite 1) yellow, with a fringe of long pale yellow pile; rest of setae on abdomen sparse, pale yellow; tergites 2–6 sclerotized, pruinose, brownish black, varyingly mottled with yellow, tergites 7–9 more grayish yellow; pleural membrane seemingly without dark markings; sternites weakly sclerotized; sternite 8 moderately sclerotized, mostly yellow but tinged with brown (partly due to greasing), bearing some long, pale yellow setae.

Terminalia as in Figure 51. Anal lobe narrow dorsally, broadened ventrally at level of lower margin of cercus where it protrudes shortly under cercus as a conspicuous, moderately setose, rounded convexity which then slightly recurves anteriorly and extends ventrally as a slender, sharp pointed, digitiform process that is somewhat longer than greatest width of anal lobe and about equal to height of cercus, its anterior margin strongly concave, and mostly shiny and bare except for about 6 minute but rather stout setae. Cercus subquadrate, only slightly higher than long, its hind margin strongly rounded; moderately setose. Hypogynial valve short, not extended to anterior margin of cercus, broadly rounded and nearly transparent posteriorly, medial margin broadly rounded, lightly sclerotized, narrowly separated basally from that of other side, valves divergent posteriorly but due to curvature most closely approach each other just posterior to base, lightly microsetose on about basal $\frac{1}{2}$. Stem of genital fork long, heavily sclerotized, about twice as long as arm; in lateral view, strongly arched dorsally (internally) from junction with arms; arm moderately broad and relatively long, arms divergent from each other in a rounded V-shape, posteromedial corner and posterior margin of arm broadly rounded and moderately sclerotized, posterolateral corner and margin heavily sclerotized with a short, strong toothlike process on anteroventral margin that projects anteriorly less than $\frac{1}{2}$ length of arm; arm narrowly attached to segment 9. Spermatheca elongate, shortly but distinctly longer than broad, heavily sclerotized, with a faint reticulate pattern that is difficult to see except at very high magnifications; with a narrow, circular, membranous area at junction with spermathecal duct.

MALE, PUPA, and LARVA. Unknown.

REMARKS: This species was described from two females collected by F. H. Snow. The lectotype, here designated, is labelled "Bill Wms. Fork, Ariz. July," [= Bill Williams River] [*Mohave/Lapaz Cos.*] and also has a red "Cotype" label that bears the name of the species. The paralectotype has similar labels except dated "Aug." instead of "July." No other collection data appear on the labels nor are given with Adam's original description. The lectotype is complete and in relatively good condition except that the apical portion of the left wing is missing. The head and abdomen of the lectotype were removed from the specimen, cleared, dissected, and placed in glycerine so the mouthparts and genitalia could be studied. These structures are in a microvial attached to the pin bearing the rest of the specimen. The lectotype was pinned through the middle of the scutum and so this structure is largely obscured, but it does not have a highly arched thorax. The paralectotype (cotype) is missing the head, abdomen, one wing and most of the legs. The two forelegs are present, one

is complete, the other is missing all tarsomeres but the basitarsus. The right midleg is missing all the tarsomeres. The left midleg, consisting of the femur, tibia and tarsus is stuck to part of the torn right wing. All the other legs and left wing are missing. The paralectotype is somewhat greasy and in poor condition. It probably is conspecific with the lectotype, but I can not definitely confirm this.

Adams mentioned nothing about the dorsum of the thorax being markedly convex and neither did Malloch (1914). However, Malloch's figure 6, on plate V, shows a very highly arched mesonotum of a female reported to be this species. This figure undoubtedly was prepared from a misidentified specimen, possibly of *S. robynae* Peterson, n. sp. Dyar and Shannon (1927) in their description of this species state, "... with a remarkably arched mesonotum;" probably basing their statement on Malloch's figure, or upon misidentified specimens, again possibly of *robynae* (see discussion under the latter species). Neither the lectotype or the paralectotype females of *S. notatum* have this type of thoracic architecture. The male ascribed to this species and described by Malloch (1914) also most likely belongs to some other species, again possibly one of the two new species described in this paper. The males examined by Malloch (1914), and Dyar and Shannon (1927), were not located and could not be examined for this study.

SPECIMENS EXAMINED: Lectotype ♀ and 1 paralectotype ♀ (see remarks).

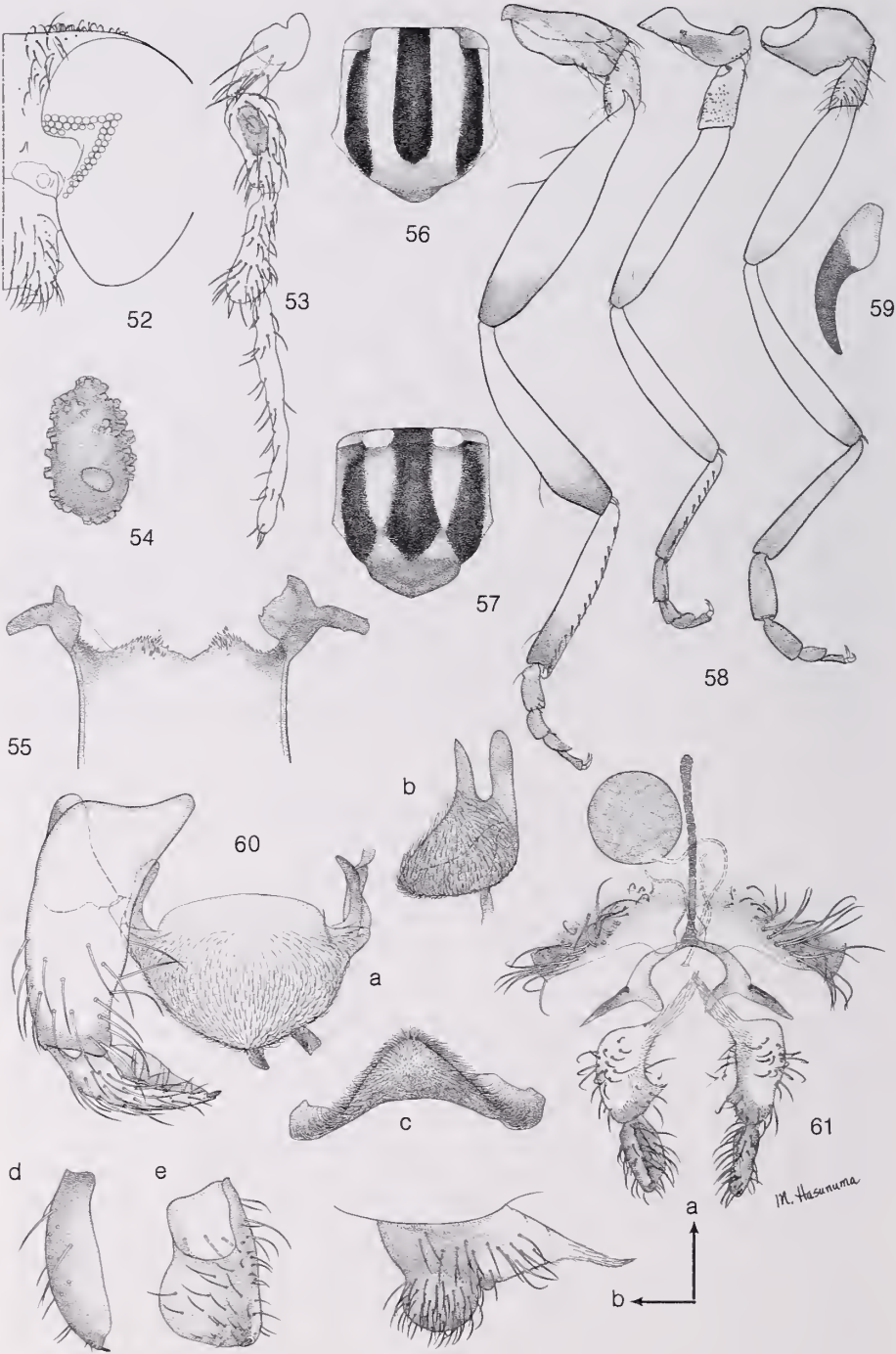
PREVIOUS RECORDS: This species has been recorded from several states including Arizona, California, Nevada, New Mexico and Texas. All records, except those from the type locality in Arizona, undoubtedly are based on misidentifications, and probably apply to *venator* in Nevada, either *venator* or *griseum* in California, and *robynae* in New Mexico and Texas.

BIOLOGICAL NOTES: Nothing is known about the biology of this seemingly rare species.

Simulium (Psilopelmia) trivittatum Malloch

Figs. 52–67, 133–138

Simulium trivittatum Malloch, 1914:30 (♀, original description, key, catalog); holotype ♀, Type #15408 (USNM); Knab, 1915a:179 (as 1914) (♀, valid name for *S. distinctum* Malloch which is preoccupied); Dampf, 1927:129 (page 7 in reprint) (citation, Mexico); Dyar and Shannon, 1927:37 (♂, ♀, description, key, distribution, figs. 78–79, 115–116); Enderlein, 1930:96 (citation); Pinto, 1931:736 (synonymy, distribution in Mexico); Vargas, 1941:121 (distribution in Mexico); Vargas, 1942:240 (♂, ♀, terminalia, fig. 13, synonymy); Lane and Vulcano, 1943:439 (♀ cibarial armature, fig. 22); Stains and Knowlton, 1943:279 (♀, distribution); Vargas, 1943:363 (♂, ♀, pupa, figs. 19–27); Vargas, Díaz Nájera and Martínez Palacios, 1943:288 (citation); Smart, 1944:134 (status of name); Smart, 1945:515 (catalog, distribution); Vargas, 1945a:65 (citation); Vargas, 1945c:202 (catalog, synonymy, distribution); Iriarte, 1946:466 (Mexico); Knowlton and Fronk, 1950:5 (Utah); Pan Amer. Sanit. Bur., 1950:143 (literature reference); Wygodzinsky, 1950:86 (pupa compared with that of *S. dinellii* (Joan)); Wygodzinsky, 1953:309 (pupa compared with that of *S. inaequalis* (Paterson and Shannon)); Peterson, 1955:114 (Utah); Rubtsov, 1956:748 (citation); Peterson, 1958:153 (Utah); Fredeen, 1959:73 (citation); Peterson, 1959:151 (around humans); Wiseman and Eads, 1960:47 (distribution in Texas); de Leon, 1963:133 (nonvector of Enfermedad de Robles);



Fallis, 1964:445 (feeding on animals and humans); Jenkins, 1964:23 (reference to parasites); Peters and Womeldorf, 1966:41 (biting humans, California); Rubtsov, 1963:531 (citation); Field, 1967:194 (citation); Travis and Labadan, 1967:237 (citation); Vulcano, 1967:22 (catalog, distribution); Field, 1969:284 (compared with *S. fuliginis* Field); Travis, Lee and Labadan, 1969:136 (citation); Forattini, Rabello and Cotrim, 1971:361 (specimens in collection of University of São Paulo); Tipton and Saunders, 1971:11 (Utah); Hall, 1974:65 (citation); Reisen, 1974:275 (biological notes); Travis, Vargas V. and Swartzwelder, 1974:191 (biting humans in Neotropical Region); Reisen, 1975a:27 (biological notes); Drummond, George and Kunz, 1988:5 (caused 10% reduction in milk flow). Crosskey, 1990:168 (citation).

Simulium (Neosimulium) trivittatum, Rubtsov, 1940:130 (assigned to subgenus *Neosimulium*).

Simulium (Simulium) trivittatum, Vargas, 1945b:77 (♂, ♀, differentiated from those of *S. mangabeirai* Vargas).

Simulium (Lanea) trivittatum, Vargas, Martínez Palacios and Díaz Nájera, 1946:169 (♂, larva, keys, description, fig. 127); Vargas and Díaz Nájera, 1948a:70 (♀, key); Vargas and Díaz Nájera, 1948b:324 (♂, key, fig. 6); Vargas and Díaz Nájera, 1949:288 (pupa, key); Dalmat, 1954:181 (Guatemala); Dalmat, 1955:156 (♂, ♀, pupa, larva, keys, descriptions, synonymy, biology, Guatemala, figs. 43–45, 160–162, 290, 330); Wirth and Stone, 1956:404 (♂, ♀, pupa, keys, California (pupa misidentified)); de Leon, 1963:133 (nonvector species).

Psilopelmia trivittatum, Rubtsov, 1968:361 (citation); Rubtsov and Garcia Avila, 1972:7 (citation).

Simulium (Psilopelmia) trivittatum, Vargas and Díaz Nájera, 1957:154 (♂, ♀, pupa, list, keys, distribution in Mexico, figs. 366–372; misidentification of at least pupa); Vargas and Díaz Nájera, 1958:14 (♂, ♀, pupa, keys, Mexico); Hidalgo Escalante, 1959:32 (pupa, larva, descriptions, biology, distribution, cuadro 2, map 6); Peterson, 1960b:100 (♂, ♀, pupa, keys, distribution, types, type localities); Díaz Nájera and Vulcano, 1961:221 (compared with *S. (P.) longithallum* Díaz Nájera and Vulcano); Anderson and Voskuil, 1963:127 (feeding on farm animals and humans); Stone, 1965:187 (catalog, synonymy, distribution); Cole, 1969:110 (California, New Mexico); Díaz Nájera, 1969:27 (compared with *S. (P.) gonzalezherrejonii* Díaz Nájera); Díaz Nájera, 1971:241 (larva, citation); Reisen, 1975b:949 (biological notes); Reisen, 1977:326 (biological notes); Coscarón, 1987:31 (list, distribution); Crosskey, 1988:467 (list, distribution).

Simulium distinctum Malloch, 1913:133 (♂, ♀, original description); holotype ♂, Type #15958 (USNM) (preoccupied Lutz, 1910:241); Malloch, 1914:30 nec Lutz (considered distinct from *S. trivittatum* Malloch); Knab, 1915a:179 (as 1914) (syn. of *trivittatum*); Dyar and Shannon, 1927:37 (syn. of *trivittatum*); Vargas, 1941:121

←
Figs. 52–61. *Simulium trivittatum*. 52. Head of ♀. 53. Palpus of ♀. 54. Female sensory organ, enlarged. 55. Proximal end of ♀ cibarium showing armature. 56. Female thorax, dorsal view. 57. Male thorax, dorsal view. 58. Hind, mid-, and fore legs of ♀. 59. Claw of ♀. 60. Male terminalia. 61. Female terminalia.

(syn. of *trivittatum*); Vargas, 1942:240 (syn. of *trivittatum*); Smart, 1944:134 (status of name); Smart, 1945:115 (syn. of *trivittatum*); Vargas, 1945c:203 (syn. of *trivittatum*); Pan Amer. Sanit. Bur., 1950:143 (literature reference); Vulcano, 1967:22 (syn. of *trivittatum*); Travis, Lee and Labadan 1969:127 (citation).

Simulium (Psilopelmia) distinctum Malloch (preoccupied Lutz, 1910), Stone, 1965: 187 (syn. of *S. (P.) trivittatum*); Crosskey, 1988:467 (syn. of *trivittatum*).

FEMALE. General body color yellow to brownish yellow, with a silvery pruinosity. Length: body, 1.7–2.2 (av 1.9) mm; wing, 1.9–2.7 (av 2.3) mm.

Head dark brown to black, densely silvery pruinose. Frons moderately broad, widening above, at vertex about $\frac{2}{3}$ as wide as at narrowest point, about $\frac{1}{3}$ width of head, and nearly as wide as long; sparsely covered with moderately long, decumbent, pale yellow pile. Clypeus concolorous with frons; slightly longer than wide; sparsely covered with moderately long, pale yellow pile. Occiput moderately covered with relatively long, pale yellow pile; with both pale and black, short postocular setae. Antenna with scape and pedicel pale yellow, concolorous or slightly lighter than flagellum which is yellow to brownish yellow; pedicel subequal in width to first flagellomere; fine pubescence pale yellow. Mandible lightly sclerotized, with about 26 fine serrations on inner margin, and about 4 larger basal serrations continuous with 4 rounded, weak serrations distally and with a distinct apical bare area on outer margin. Blade of maxilla with 24 retrorse teeth. Palpus pale yellowish brown to brown, distal 2 palpomeres slightly paler than palpomere 3; with pale setae admixed with some brownish setae, sometimes brownish setae predominant; palpomere 5 about $\frac{1}{3}$ longer than palpomere 3. Sensory vesicle of third palpomere rather large, slightly over $\frac{1}{2}$ as long as its segment, proximally situated, its neck short, arising near middle and extended vertically, with a narrow ovoid mouth. Median proximal space of cibarium shallow, nearly twice as broad as deep, broadly U-shaped, with a shallow median notch flanked by 2 short, submedian lobes each bearing a variable series of very short, fine, setalike denticles; dorsolateral arm short, broad, and heavily sclerotized.

Thorax pale yellow to brownish. Postpronotum pale yellow, posteromedian corner tinged with brown; covered with moderately long, semi-erect to erect, pale yellow pile. Scutum yellow, with 7 alternating stripes of nearly uniform width; median and 2 sublateral stripes chocolate brown to dark brown; median stripe reaching anterior margin of thorax but terminating posteriorly just before prescutellar declivity; sublateral stripe usually terminating at postpronotal lobe with only a trace of brown extended forward onto posteromedian corner of this lobe, this brown stripe extended posteriorly almost to anterolateral corner of scutellum. Submedian and marginal stripes conspicuously silvery to whitish pruinose, marginal stripe extended around lateral and hind margins, submedian pale stripe united with posterior declivity that is broadly pruinose; notopleural ridge often faintly brownish; scutum densely covered with short, recumbent, pale setae on pale stripes and brown setae on dark stripes, pale pile longer along lateral margins and still longer and more erect posteromedially on declivity of scutum. Scutellum yellow tinged with brown; densely covered with long, mostly yellow setae, some of which have dark bases, and with some brownish setae usually present. Postnotum yellowish brown to dark brownish black, with a dense whitish pruinosity. Pleuron densely whitish pruinose; ground color varying from mostly pale yellow mottled with brown, to mostly brown; katepisternum brown; anepisternal membrane pale yellow; mesepimeral tuft pale yellow, sometimes with a faint golden tinge.

Wing membrane hyaline; veins yellowish to white. Stem vein and base of costa with pale yellow setae; fringe of calypter and anal lobe pale yellow. Halter yellowish white basally, knob white, with pale pile.

Legs: Foreleg yellow, tip of tibia faintly and narrowly tinged with brown; tarsomeres brown, slightly swollen. Midleg yellow, coxa tinged with brown, tip of femur faintly and narrowly tinged with brown, about apical $\frac{1}{4}$ of basitarsus brownish, apical $\frac{1}{2}$ of 4th tarsomere and all remaining tarsomeres brown, sometimes 4th tarsomere entirely brown. Hind leg yellow, except coxa tinged with brown to all brown, femur brown on about apical $\frac{1}{4}$ and more extensively tinged with brown along dorsal margin on apical $\frac{1}{2}$; tibia brown on apical $\frac{1}{3}$ to $\frac{1}{2}$, basitarsus brown on apical $\frac{1}{2}$ and apical $\frac{1}{2}$ of 4th tarsomere distal to pedisulcus and remaining tarsomeres brown; hind basitarsus about 5 times as long as broad; calcipala small, inconspicuous, pedisulcus small, inconspicuous but deep. Claw simple, evenly curved from near base, base sometimes pale yellow, rest of claw black. Legs with pale yellow setae on yellow portions, and dark setae on brown portions, hind femur with some brownish setae along dorsal margin; hind margins of posterior tibia and tarsus with 3 or 4 dark setae that are much longer than others.

Abdomen grayish yellow; basal scale (tergite 1) more yellowish, hind marginal area brownish, with a fringe of long pale yellow pile; tergites 2–6 sclerotized, dark matte brown, moderately and evenly covered by short, recumbent, yellow and brownish setae; tergites 7–9 uniformly grayish yellow, with longer, mostly yellow setae but a few brownish setae may be present; pleural membrane of segments 3–7 with subquadrate dark markings, segment 2 sometimes with a small, faint brown spot; sparsely covered with short pale setae, and with dark setae on brown spots. Sternites 1–7 weakly sclerotized, scarcely evident, sternite 8 heavily sclerotized, dark brown, with long, dark brown setae. Terminalia as in Figure 61. Anal lobe not produced beneath cercus, broad dorsally, with a small but usually distinct posteriorly directed bump just below cercus, then tapered ventrally to a long, slender, fingerlike, setose process that is distinctly longer than distance from dorsal margin of anal lobe to ventral margin of bump, and is about $\frac{2}{3}$ as long as height of cercus; this ventral process somewhat variable in thickness. Cercus subquadrate, about as high as long, hind margin strongly rounded. Hypogynial valve short, not reaching level of cercus, with a small, transparent, bare, rounded lobe; lobes of each side diverging distally, separated by a distance greater than distal width of a lobe; medial margin of lobe scarcely sclerotized; lightly microtrichose basomedially and along proximal margin. Stem of genital fork long, moderately sclerotized, about $\frac{2}{3}$ longer than arm; arm short, and with a prominent, sclerotized, toothlike process on anterolateral margin; arm narrowly attached to tergite 9. Spermatheca globular, moderately sclerotized, with a faint, loose, reticulate pattern.

MALE. General body color black. Length: body, 1.6–2.6 (av 2.1) mm; wing, 1.7–2.0 (av 1.8) mm.

Frons and clypeus densely pruinose, medial marginal area between eyes, and clypeus with pale brownish to pale yellowish pile. Occiput with long, pale yellow setae. Antenna yellow; pedicel and first flagellomere equal in length; fine pubescence pale yellow. Palpus brown to black, with mostly coppery brown pile; palpomere 5 slightly more than twice as long as palpomere 3. Sensory vesicle about $\frac{1}{6}$ to $\frac{1}{4}$ as long as its segment; neck short, with a small round mouth.

Postpronotum yellow except for medial corner which is black and continuous with black sublateral stripe of scutum; grayish pruinose; with pale yellow pile. Scutum black, but with 7 alternating stripes as follows: each lateral margin yellow, and 2

submedian stripes with a variously intense yellow ground color, all brightly grayish pruinose and united with pruinosity of posterior declivity, plus a median and 2 sublateral matte black stripes that are wider than pruinose stripes; scutum densely covered with short, recumbent, pale yellow pile that is longer laterally and posteromedially, setae on black stripes appear coppery brown in anterior view. Scutellum yellowish brown, paler than scutum; densely covered with long, yellow setae some of which may have dark bases, interspersed with some entirely black setae. Postnotum concolorous with or slightly paler than scutum, lightly pruinose. Pleuron varying from black to yellowish brown, densely grayish pruinose; anepisternal membrane usually paler brownish to yellowish gray; mesepimeral tuft brownish.

Wing membrane hyaline; veins pale yellow; base of costa and stem vein with mixed yellow and black setae although sometimes black setae are most numerous; fringe of calypter and anal lobe varying from all pale yellow to some with black bases to mixed brownish and yellowish setae. Knob of halter usually white but sometimes yellow, stem brown with mostly brownish setae.

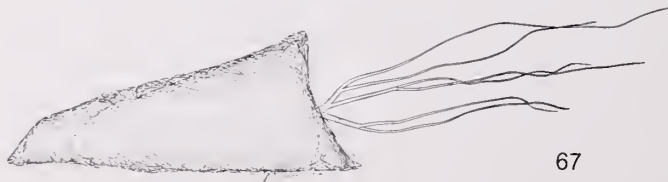
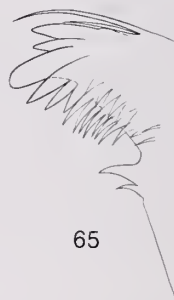
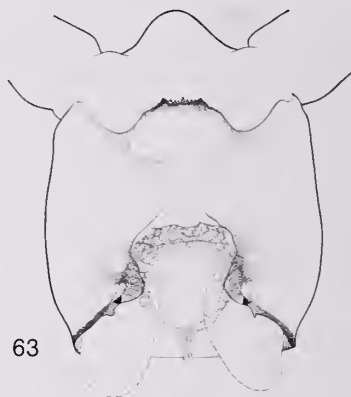
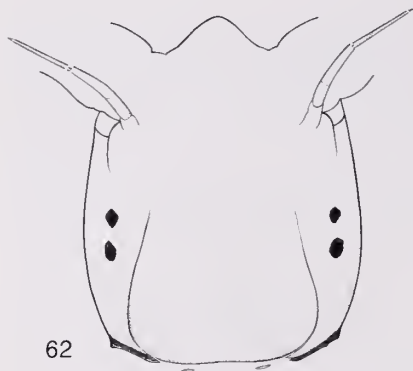
Foreleg yellow except for apical $\frac{1}{4}$ to $\frac{1}{3}$ of tibia, and tarsus which are black, with mostly pale yellow setae except for a few long, black setae posterodorsally on femur, and black to coppery brown setae on tarsus; midleg yellow except tibia may be tinged with black apically on dorsal surface, and apical $\frac{1}{3}$ to $\frac{1}{2}$ of basitarsus and remaining tarsomeres which are black, with mostly yellow setae except black setae present on dark areas and near tip of tibia; hind leg black except yellow on basal $\frac{1}{4}$ to $\frac{1}{2}$ of femur and tibia, basal $\frac{2}{3}$ to $\frac{3}{4}$ of basitarsus, and basal $\frac{1}{2}$ of second tarsomere, with mostly pale yellow setae on yellow areas and black setae on black areas; however, femur, and especially tibia with a few long, black dorsal setae; hind basitarsus varying from 4.6 to 6.5 times as long as broad.

Abdomen mostly black dorsally, grayish yellow laterally and ventrally; anterior $\frac{1}{2}$ of basal scale yellow and posterior $\frac{1}{2}$ black, with a fringe of long pile varying from pale yellow with dark bases, to mixed pale yellow and coppery brown, to all brown or black; tergites 2, 6 and 7 each with a central black spot and lateral $\frac{1}{3}$ or more yellowish brown and densely grayish pruinose; tergites 3–5 and 8–9 black; tergites moderately covered with short, pale yellow and coppery brown setae dorsally, and longer pale yellow to brownish pile laterally; tergite 10 small, rectangular to subquadrate, varying from about equal in length and width to about $\frac{1}{2}$ wider than long; sternites 3–8 nearly equal in size, rectangular, lightly sclerotized, sparsely clothed with short, yellowish brown to black setae on posterior $\frac{1}{2}$.

Terminalia as in Figure 60. Gonocoxite rectangular, tapered distally, slightly but distinctly longer than greatest width, sparsely covered with pile on distal $\frac{2}{3}$. Gonostylus short, 1.5–2.0 times as long as greatest width at base; apical margin with outer corner broadly rounded, obliquely continuous to inner distal corner that is produced as a short but distinct, triangular process bearing one tiny terminal spine, this process accentuated by concave inner margin of gonostylus. Ventral plate of aedeagus broadly subtriangular; in ventral view, greatest width occurring just distal to basal arms, lateral margins tapered distally to apical margin which, in flat view, is straight or slightly convex, or if basal arms somewhat tilted ventrally (inwardly) then apical margin curved with a short, broadly rounded, median point, proximal margin between basal arms variously convex medially; basal arm short, heavily sclerotized, broad, tapered to a pointed apex; in lateral view, apical margin with a short, ventral lip; both dorsal and ventral surfaces densely setose. Median sclerite of aedeagus short, stem often slightly longer than arms or these subequal in length, stem

sclerotized, with a series of concentric appearing folds or ridges that extend into basal portion of each arm; arms less sclerotized, well differentiated, slightly widened distally, outer surface of hoodlike covering lightly sclerotized, less so around gonopore; aedeagal membrane densely covered with irregular and clumplike to combllike series of minute setulae having conspicuous bases (appears granular). Plate of endoparameral organ subrectangular, distal (posterior) margin thickened rimlike, with a few ridgelike cuticular thickenings, remainder of plate smooth; arm short, twisting inwardly, ventrally then dorsally roughly in an S-like configuration, with 4 or 5 broad, long, well developed, basal spines that merge with a cluster of 25–35 smaller, more irregular, weakly defined apical spines.

PUPA. Length 2.2–2.8 (av 2.5) mm. Respiratory organ (Fig. 68) 2.2–2.8 (av 2.5) mm, often as long as pupa or nearly so; consisting of a very short, slender base, covered with minute combllike ridges loosely arranged scalelike, and minute spicules; with 6 filaments arranged in 3 pairs (sometimes dorsalmost filament of outer dorsolateral branch with a secondary filament that arises a considerable distance from base and results in a total of 7 filaments); petiole of inner mediolateral pair long, often nearly twice as long as others, sometimes arising from base of outer dorsolateral pair of filaments and sometimes arising separately; petioles of outer dorsolateral and ventrolateral pairs variable but usually subequal in length; filaments pale whitish to grayish, with closely placed, irregular and poorly defined, annulations. Head sparsely to moderately covered by small, raised granules that are arranged singly or in small groups, sometimes integument largely glossy; antennal sheath of male short, reaching only about $\frac{1}{3}$ distance to hind margin of head; antennal sheath of female reaching about $\frac{5}{8}$ distance to hind margin of head; frons with 2 short, pale, curved or straight, simple setae just mediodorsal to base of antenna; clypeus with a short forked, pale seta medioventral to base of antenna. Dorsum of thorax with sparse to moderately dense, small, raised granules that are arranged singly or in small irregular clusters, when granules sparse integument appearing glossy; with 3–5, usually 4, short, slender, pale, simple or bifurcate trichomes laterally above level of base of respiratory organ. Chaetotaxy of each lateral half of abdominal tergites as follows: tergite 1 largely bare, with 1 or 2 anterolateral setae and 3 to 4 tiny posteromedial setae that are difficult to see; tergite 2 with a sublateral longitudinal series of 2–3 setae and a posteromedial row of 4 short but more distinct setae; tergites 3 and 4 each with a sublateral row of 4 stout, anteriorly directed hooks near hind margin and a slightly more anterior single seta; tergite 5 bare; tergites 6–9 each with a row of short, fine, posteriorly directed spinules near anterior margin, those of tergites 6 and 7 broadly interrupted in middle, those of tergites 8 and 9 entire or only narrowly interrupted at middle; caudal spines very short, straight, tips subparallel to slightly divergent, bases widely separated, each situated on a slightly swollen convexity. Chaetotaxy of each lateral half of sternites as follows: sternites 2–3 each with 1 or 2 small submedian setae; sternite 4 with 1 small, slender, submedian hook and 1 seta just anteromedial to hook, hook smaller than those of following segments; sternite 5 with 2 closely placed submedian hooks; sternites 6–7 each with 4 longer, rather stout hooks, lateral hooks of each pair separated from submedian hook but not lying in pleural membrane, hooks varying from simple to bifid to trifid; sternites 8–9 usually bare but sometimes with 1 or 2 fine setae. Cocoon grayish, slipper-shaped and tightly woven, anterior margin simple, only slightly thickened; floor well formed, extended anteriorly about $\frac{1}{2}$ length of cocoon; in lateral view, anterior margin of cocoon weakly concave and slightly slanted anteroventrally so anteroventral corners extend in front of dorsal margin of cocoon.



LARVA. Length 4.2–5.8 (av 4.9) mm. Body color dorsally pale brownish yellow to grayish yellow anteriorly, posterior segments darker brownish yellow, entire abdomen ventrally more transparent whitish, intersegmental lines rather broad, slightly lighter than rest of abdomen. Head capsule (Figs. 62, 63) pale yellow to light brownish yellow, postgena often slightly darker; head spot pattern similar to that of *mediovitatum*, spots mostly obscure except posteromedian spot which is large, pale yellow, and entirely surrounded by a narrow, darker brown, ringlike area that widens posteriorly to encompass 2 posterolateral spots, area anterior to head spots entirely pale yellow verging to transparent. Antenna in fresh specimens entirely brown (as dark as mandibular phragma) except for base of proximal segment and extreme apex of second segment and base of distal segment which are colorless, in older specimens this coloration fades to a paler brownish color; slightly longer to subequal in length to stalk of labral fan; proportions of segments (basal to apical) about 15:15:16. Labral fan with 34–36 primary rays. Hypostoma as in Figure 66; median tooth distinctly longer than outer lateral teeth which are only slightly longer than well developed sublateral teeth, with 2 well developed paralateral teeth and 3–4 lateral serrations; 3–5 lateral hypostomal setae that decrease in length posteriorly and with 2–3 pairs of shorter sublateral setae near posterior margin of hypostoma. Hypostomal cleft broadly rounded, anterior margin variably distinct, usually somewhat longer than wide, extended about $\frac{1}{2}$ distance to base of hypostoma; hypostomal cleft, hypostomal bridge and hypostoma all subequal in length. Mandible with 5–6 apical teeth only 2 of which are stouter than others; dorsal process near base of primary teeth distinct, slender and heavily sclerotized; about 8 very fine and difficult to see combteeth; inner subapical ridge usually with 1 variably sized but usually relatively large serration, occasionally a much smaller second serration present adjacent proximally to base of larger serration. Maxillary palpus about 4 times as long as width at base, tapered distally. Lateral plate of proleg moderately broad, lightly sclerotized, extended about $\frac{1}{2}$ length of apical segment; circle of apical hooks in about 25–28 rows. Anal setulae few, very minute and widely scattered; anal papillae usually consisting of 3 simple lobes whose bases are situated close together, and outer lobes divergent, but not strongly so, from middle lobe; outer lobes frequently with a much smaller lobule or an indication of a secondary lobule at base posteriorly, more rarely 2 secondary lobules present, median lobe less frequently with 1 or 2 secondary lobules at base posteriorly (1 specimen was noted to have only 2 primary lobes). Anterodorsal arm of anal sclerite moderately broad, tapered and bluntly pointed distally, weakly to moderately sclerotized, varying from just slightly to about $\frac{1}{2}$ shorter than posteroventral arm which is slender and heavily sclerotized. Posterior circle of hooks consisting of about 12 hooks in 61–70 rows. Ventral tubercles small but distinct.

REMARKS: The current description of the female was based on a series of reared specimens, and consequently the colors might be somewhat darker in field caught specimens than is evident in the material at hand. Greasy specimens also appear

←

Figs. 62–68. *Simulium trivittatum*. 62. Head capsule of larva, dorsal view. 63. Head capsule of larva, ventral view. 64. Respiratory histoblast of mature larva. 65. Tip of mandible of larva. 66. Hypostoma of larva. 67. Cocoon and pupa, lateral view. 68. Basal portion of respiratory organ of pupa.

darker than the colors described above. In available female specimens, the ventral digitiform process of the anal lobe varied somewhat in its length and thickness but is quite slender. This process on the holotype female of *trivittatum*, several specimens from eastern Texas, and a paratype female of *S. distinctum* Malloch, is relatively long and stout whereas in other females it is slightly shorter and more slender. However, I consider this difference to be within the normal range of variation. What is considered here as *trivittatum*, based upon examination of the holotype, is not the same species as specimens in the USNM collection bearing this name from parts of Mexico and Guatemala south to Peru. Specimens from the latter countries have dark pile on the stem vein, and the ventral prolongation of the anal lobe of the female is thicker and more pilose; these specimens probably represent an undescribed species. The previous reports of *trivittatum* from Mexico and Guatemala have not been verified, and may or may not represent true *trivittatum*.

The pupa shows some variation in the density of the small granules on the frons, clypeus, and dorsum of the thorax. In most cases these granules are moderately dense and easily distinguished. More rarely these granules are few and widely distributed giving the integument a more glossy appearance. Adults from the two types of pupae cannot be differentiated and this variation is considered within the normal range of variation for the species. Also, and again more rarely, the dorsal filament of the dorsolateral group produces a secondary filament usually some distance from the base, resulting in 7 filaments instead of the usual 6. Pupae of the two forms agree in all other respects.

The pinned holotype female of *trivittatum* is in reasonably good condition except the left flagellum of the antenna and the left wing are missing, as are the distal four tarsomeres of the left middle leg, the femur of the left hind leg, and all the tarsomeres of the right hind leg. The tibia and tarsus of the left hind leg are detached and stuck to the right middle leg. The uppermost label on the pin reads, "Tampico Mex. 17.12." The next lower label reads, "EA Schwarz Collector." The next to bottom label is a red type label bearing the type number 15408, U.S.N.M., and the bottom label is Malloch's identification label reading, "*Simulium trivittatum* Malloch." The prolongations of the anal lobes are clearly visible.

The holotype male of *distinctum* is also pinned, and at the time of this writing, is complete and in good condition except that the eyes are collapsed. The scutal pattern of *distinctum* matches that of *trivittatum* and the two species are synonyms. There is a mite attached to the venter just behind the right hind leg. The uppermost label on the pin says, "Devil Riv. v.5.07 Tx." The next lower label is much smaller and says, "at light." The third or middle label says, "Bishopp & Pratt coll." The next to bottom label is a red type label bearing the number 15958 U.S.N.M., and the bottom label is Malloch's identification label reading, "*Simulium distinctum* Malloch (Type)."

SPECIMENS EXAMINED (total—302 males; 276 females; 931 pupae and pupal skins; 2,757 larvae): ARIZONA: *Cochise Co.*, April 13–June. (A). CALIFORNIA: *Butte Co.*, June 5, (A). *Fresno Co.*, June–July (A). *Inyo Co.*, May 10, (P). *Kern Co.*, July 29, (A). *Merced Co.*, September, (A). *Riverside Co.*, May 10–28, (A). *San Bernardino Co.*, March 2–December 13, (A). *Shasta Co.*, August 1, (A). *Yolo Co.*, October, (A). NEW MEXICO: *Bernalillo Co.*, June 18, (A). *Catron Co.*, June 1, (A). *Eddy Co.*, May 6–14, (A, P, L). *Sandoval Co.*, July 4, (A). *Taos Co.*, May 26, (A). OKLAHOMA: Sheep Creek, Ada, October 15, 1937, K. & R. Weddle, (A). TEXAS:

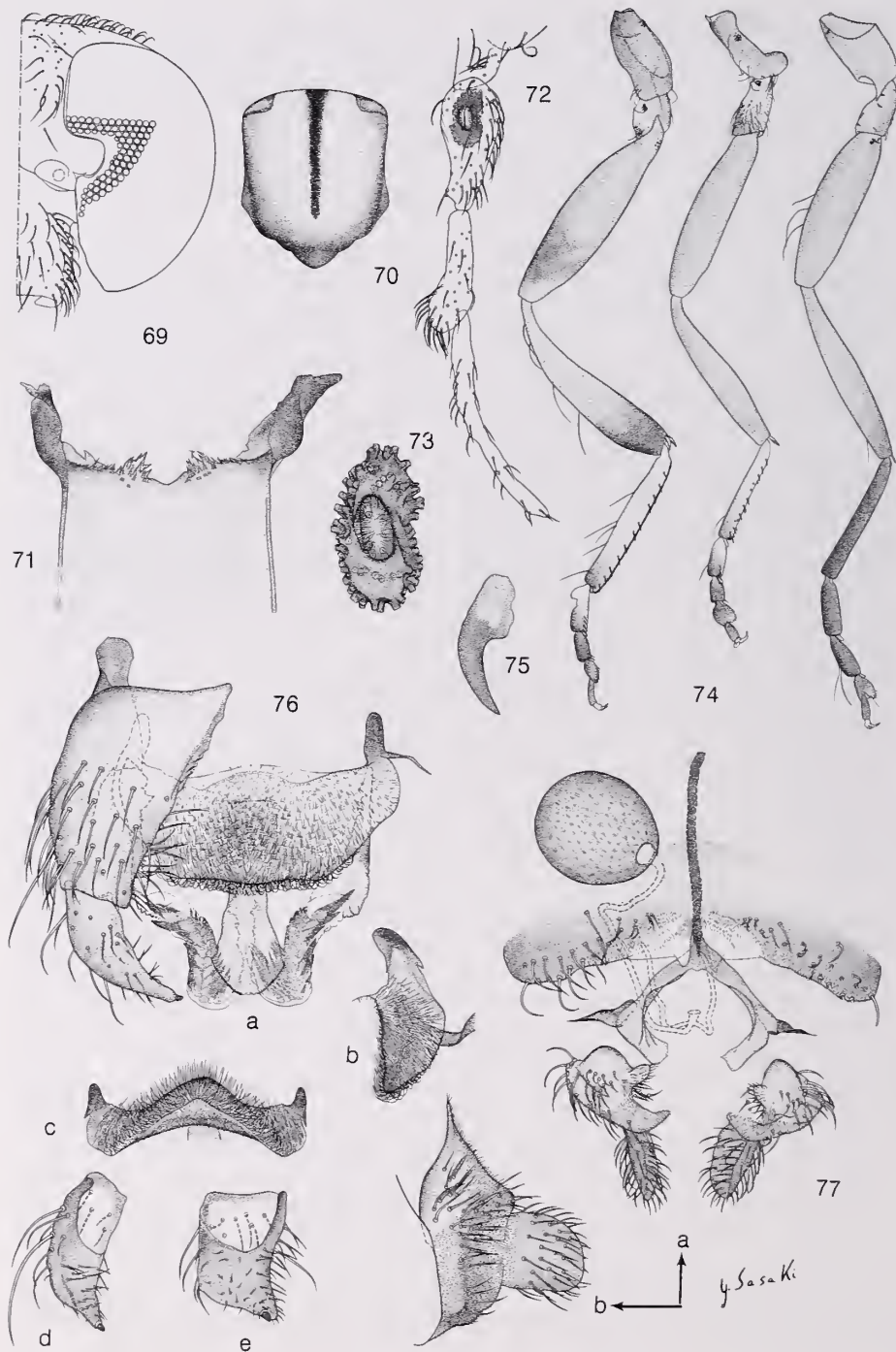
Bandera Co., March 1–October 16, (A, P, L). *Brewster Co.*, May 11, (A, P). *Burnet Co.*, February 2, (P, L). *Edwards Co.*, March 27–April 22, (A, P, L). *Kerr Co.*, February 11–November, (A, P, L). *Kimble Co.*, February 19–May 8, (A, P, L). *Kinney Co.*, May 9–10, (A, P, L). *Maverick Co.*, May 9, (A, P, L). *Menard Co.*, April 23–October 9, (A, P, L). *Pecos Co.*, October 17, (A). *Real Co.*, March 27–June 26, (A, P, L). *Travis Co.*, July 28, (P, L). *Uvalde Co.*, April 20–June 13, (A, P, L). *Val Verde Co.*, April 20–June 13, (A, P, L) (includes paratypes). *Williamson Co.*, April 18, (A, P, L).

PREVIOUS RECORDS: U.S.: Arizona, California, Montana, New Mexico, Oklahoma, Texas, Utah. MEXICO: Aguascalientes, Coahuila, Colima, Chihuahua, Guanajuato, Guerrero, Jalisco, Michoacan, Morelos, Nuevo Leon, Oaxaca, Puebla, San Luis Potosi, Tamaulipas, Veracruz, Zacatecas. GUATEMALA: Chimaltenango.

BIOLOGICAL NOTES: Despite the fact that this is a fairly widespread species, there is relatively little known about its biology, and what has been reported must be considered suspect. This arises from the fact that *trivittatum* has been recorded from as far south as Guatemala (and there are specimens in the USNM collection from Peru labelled as *trivittatum*). Although I did not conduct a detailed study of these specimens as part of this revision, it is clear that at least some of the Central and northern South American specimens in the USNM are not conspecific with the North American species, and thus the biological information reported for the more southern collections could apply to one or more species. As a result, I have confined my literature citations, as far as biological data is concerned, to that reported on North American collections of *trivittatum*.

This multivoltine species often occurs with *mediovittatum* or in the same type of habitats within its range outside of Texas. Immatures probably can be found through most of the year in the warmer, more southern regions of its range. Females have been reported to feed on farm animals as well as humans (Anderson and Voskuil, 1963; Fallis, 1964; Peters and Womeldorf, 1966; Drummond et al., 1988). Both Anderson and Voskuil (1963), and Peters and Womeldorf (1966) reported reduced milk production in cows bothered by this species. Specimens collected from the ears of horses are housed in the USNM collection. Some general remarks on various aspects of the biology of this species have been given by Reisen (1974, 1975a,b), and Jenkins (1964) lists the parasites that have been recorded from *trivittatum*. One intersex specimen (Topanga Canyon, Los Angeles, California, May 14, 1952) was discovered whose head has female eyes but whose frons is narrow and decreases in width dorsally, the blade of the maxilla has a reduced number of retrorse teeth, and the mandible has only a few weak indications of serrations. The palpus is female with the typical, but slightly reduced, sensory organ of the third palpomere. All legs have typical male claws, and the cerci are small. The abdomen bears both male and female genital components although most of these are deformed. The hypogynial valves are present and just lateral to them are the paired gonocoxites and gonostyli. Internally there are the genital fork and spermatheca, but there are no traces of the ventral plate or median sclerite of the aedeagus, although the arms of the parameres are present with well defined spines.

Some of the literature treating various aspects of the biology of specimens identified as *trivittatum* from Central and South America include the following: Dalmat (1955), Hidalgo Escalante (1959), de Leon (1963), and Travis et al. (1974).



Simulium (Psilopelmia) venator Dyar and Shannon

Figs. 69–80, 139–143

Simulium venator Dyar and Shannon, 1927:36 (♂, ♀, original description, keys, distribution, figs. 92–93); holotype ♀, Type #28343 (USNM); Hearle, 1932:18 (citation); Knowlton, 1935:1073 (attacking horses); Knowlton, Harmston and Hardy, 1938:104 (Idaho, Utah); Twinn, 1938:54 (Idaho, Utah); Stains and Knowlton, 1943:279 (syn. of *S. mediovittatum* Knab); Smart, 1945:508 (syn. of *mediovittatum* [sic] (apud Stains and Knowlton, 1943); Vargas, 1945c:159 (syn. of *mediovittatum*); Knowlton and Fronk, 1950:6 (Utah); Pan Amer. Sanit. Bur., 1950:144 (literature reference); Peterson, 1955:114 (Utah); Peterson, 1959:151 (citation); Fallis, 1964:445 (on horse); Travis, Lee and Labadan, 1969:137 (citation); Tipton and Saunders, 1971:11 (Utah).

Simulium (Neosimulium) venator, Rubtsov, 1940:130 (assigned to subgenus *Neosimulium*).

Simulium (Lanea) venator, Wirth and Stone, 1956:404 (♂, ♀, keys, California).

Simulium (Psilopelmia) venator, Peterson, 1960b:100 (♂, ♀, keys, distribution, type, type locality); Stone, 1965:187 (catalog, distribution); Cole, 1969:110 (California, Nevada); Crosskey, 1988:467 (list, distribution). Crosskey and Lowry, 1990:233 (paratype in BM(NH)).

Simulium beameri Stains and Knowlton, 1943:279 (♂, ♀, original description, key, distribution, figs. 70, 80); holotype ♀ (UKaL); Smart, 1945:501 (catalog as valid species); Vargas, 1945c:119 (catalog as valid species); Byers et al., 1962:164 (type depository); Travis, Lee and Labadan, 1969:124 (citation).

Simulium (Lanea) beameri, Vargas, Martínez Palacios and Díaz Nájera, 1946:107 (citation).

Simulium (Psilopelmia) beameri, Stone, 1965:187 (catalog, syn. of *S. venator* Dyar and Shannon); Cole, 1969:110 (syn. of *venator*); Crosskey, 1988:467 (syn. of *venator*).

FEMALE: General body color varying from dark yellowish brown to black. Length: body, 1.4–2.2 (av 1.8) mm; wing, 1.9–2.5 (av 2.2) mm.

Head entirely black, densely grayish pruinose. Frons moderately broad, at vertex only slightly wider than at narrowest point and as wide as long, about $\frac{1}{3}$ width of head or slightly more; sparsely covered with moderately long, whitish pile. Clypeus concolorous with frons; at most, slightly longer than wide; sparsely covered with moderately long, whitish pile. Occiput moderately covered with long, whitish pile. Antenna with scape and pedicel yellow with yellowish setae, flagellum brownish yellow, darker dorsally, paler ventrally, sometimes flagellum quite brown especially in dried specimens; fine pubescence pale yellow; first flagellomere slightly longer and wider than pedicel, remaining flagellomeres, except terminal flagellomere, subrectangular, nearly twice as wide as long. Mandible moderately sclerotized along inner

← Figs. 69–77. *Simulium venator*. 69. Head of ♀. 70. Female thorax, dorsal view. 71. Proximal end of ♀ cibarium showing armature. 72. Palpus of ♀. 73. Female sensory organ, enlarged. 74. Hind, mid-, and fore legs of ♀. 75. Claw of ♀. 76. Male terminalia. 77. Female terminalia.

margin with about 20–25 very small serrations, thinner and more weakly sclerotized along outer margin with only 3 or 4 larger but much weaker and rather widely spaced serrations. Blade of maxilla with about 23 well developed, retrorse teeth. Palpus dark brown to black with pale yellowish setae, sometimes 4th and 5th palpomeres slightly paler and more yellowish; palpomeres 3 and 4 subequal in length, palpomere 5 somewhat variable in length but usually about $\frac{1}{3}$ longer than palpomere 3. Sensory vesicle moderately long and slender, situated basally, often at extreme base, and about $\frac{1}{2}$ to $\frac{3}{4}$ as long as its segment, without a neck or, at most, a faint indication of a neck that arises medially and with an enlarged ovoid mouth. Median proximal space of cibarium shallow and broadly U-shaped, each side with a short, sharply pointed, sublateral projection that is continuous with a sclerotized strut from lateral arm, each projection separated by a rather wide bare area, and bearing a series of about 14 minute denticles, some of which are slender and setalike, these denticles extended laterally to base of lateral arm; dorsolateral arm short, broad, heavily sclerotized and rounded distally.

Thoracic color pattern quite variable but usually as follows for pinned specimens: lobe of prescutum small, usually yellow with pale yellow pile, but lobe sometimes brownish to blackish. Postpronotum usually yellow, sometimes darker brownish to black but mostly with traces of yellow along edges, and with an overlying grayish pruinosity; moderately covered with long, semi-erect to erect, pale yellow pile. Scutum with anterior and lateral margins narrowly yellow or if brownish or black then tinged with yellow; with 2 broad sublateral black bands that extend to or just short of lateral corners of scutellum and variably unite across posterior declivity of scutum, sometimes broadly united, sometimes more narrowly so or just in front of scutellum, and sometimes they do not unite at all with posterior declivity which is yellowish; between these sublateral bands there is a much narrower, straight, orange brown stripe that is bordered with darker brownish or blackish areas but with a distinct yellowish tinge, this central stripe extended to prescutum with its anterior portion distinctly black and spotlike, posteriorly this central stripe terminates abruptly at posterior declivity of scutum but sometimes it fades into yellowish brown or black area of posterior declivity; entire scutum with a dense grayish pruinosity that somewhat obscures underlying pattern except for median stripe which is without pruinosity; anterolateral corner of scutum between postpronotum and median stripe often with a distinct triangular grayish spot that is more densely pruinose than rest of scutum; scutum dorsally moderately covered with short, recumbent, pale yellow pile, lateral margin and posterior declivity with longer, more erect, pale yellow pile. Scutellum yellow to brownish yellow, densely covered with long, pale yellow setae. Postnotum brownish black, densely grayish pruinose. Pleuron black anteriorly, variably more yellow, often mottled with darker areas, medially and posteriorly, grayish pruinose; anepisternal membrane varying from brownish black to yellow, often mottled, and grayish pruinose; mesepimeral tuft pale yellow.

Wing membrane hyaline; veins yellowish; base of costa and stem vein with pale yellow pile; fringe of calypter and anal lobe pale yellow. Halter pale yellow with pale yellow setae.

Legs: Foreleg yellow except for slender tarsus which is black, sometimes about basal $\frac{1}{4}$ of first tarsomere yellowish, setae of yellow areas pale yellow, those of black areas largely black but mixed with some pale yellow setae. Midleg and hind leg each

with coxa black, trochanter, femur, tibia and all but tips of basal 2 tarsomeres yellow, tips of these segments and remaining tarsomeres black, sometimes hind femur slightly brownish dorsally and tibia darkened on about apical $\frac{1}{4}$; setae pale yellow on yellow parts of legs and black on black parts of tarsi; hind basitarsus slender, parallel sided, about 7 times as long as broad. Claw short, slender, simple, evenly curved from base.

Abdomen largely pale yellow, basal scale (tergite 1) with fringe of long, pale yellow pile; tergites 2–7 each with a small, subquadrate brown to black median spot, those of tergites 2 and 7 smaller, paler and more diffuse, tergites 2 and 4 each with a more elongate gray mark on each side ventral to tergite, tergites 8 and 9 heavily sclerotized and dark brown to black; setae of tergites rather sparse and largely pale yellow except for some dark setae on darkened areas of tergites and laterally on grayish spots of segments 2 and 4; sternites weakly sclerotized and difficult to discern, sparsely covered with short, pale yellow setae; sternite 8 weakly sclerotized on about anterior $\frac{2}{3}$ and heavily sclerotized and dark brown to black on about posterior $\frac{1}{3}$, darkened area with patch of longer black setae. Terminalia as in Figure 77. Anal lobe narrow dorsally, slightly longer than portion ventral to cercus, with a slender, vertical, sclerotized strip bearing a row of about 12–14 longer setae; anal lobe broadened ventrally below cercus, posterior margin with a small but noticeable tuberclelike process bearing 1 or 2 longer, stout setae, this process not extended posteriorly below ventral margin of cercus or only faintly so, ventral margin of anal lobe produced as a slender digitate lobe with a series of short setae along hind margin, anterior margin bulging anteriorly then curved posteriorly to form a bare anterior margin; length of anal lobe ventral to cercus distinctly greater than greatest width at level of ventral margin of cercus; anal lobe moderately setose with both short and longer setae. Cercus subquadrate, slightly higher than long, hind margin strongly rounded. Hypogynial valve short, not reaching cercus, broadly rounded posteriorly, medial margin lightly sclerotized, both lobes rather widely separated and diverging distally; lightly setose. Stem of genital fork long, slender, heavily sclerotized, about 3 times as long as arm; arms short, slender, widely divergent, each expanded apically into a moderately large, subquadrate plate with a short, toothlike process on anterodorsal margin; arm narrowly attached to tergite 9. Spermatheca somewhat ovate, longer than broad, slightly tapered toward spermathecal duct, heavily sclerotized, with a small rounded membranous area at junction with spermathecal duct.

MALE. General body color black. Length: body, 1.9–2.9 (av 2.4) mm; wing, 1.9–2.4 (av 2.1) mm.

Medial marginal area between eyes, upper margin of frons, and clypeus with erect, pale yellow pile. Occiput with long, pale yellow setae. Antenna, in alcohol preserved specimens, entirely yellow to pale brown; in dried specimens, yellowish brown to black but with base of first flagellomere yellow; first flagellomere about $\frac{1}{4}$ longer than pedicel; fine pubescence pale yellow. Palpomere 3 black, 4 and 5 paler brownish, all with yellow pile interspersed with black setae; palpomere 5 slightly more than twice as long as palpomere 3. Sensory vesicle about $\frac{1}{4}$ as long as its segment; neck very short, with a small, round mouth.

Postpronotum and a small, anterolateral portion of adjacent median projection of scutum yellowish; with yellow pile. Scutum usually black over most of dorsum but sometimes with a broad, median, underlying yellow to orange stripe that nearly reaches or is continuous with posterior declivity, sometimes this coloration confined,

in varying intensities and extent, to posterior declivity; lateral margin of scutum often narrowly yellowish to above wing base, adjacent notopleuron mostly black; entire scutum lightly grayish pruinose dorsally, its anterior and especially lateral margins and posterior declivity densely pruinose, and, especially in anterior view, with a bright, silvery pruinose, ovoid to subtriangular spot just medial and posterior to postpronotal lobe, this spot reaching about $\frac{1}{2}$ distance to base of wing; densely covered with short, recumbent, pale yellow pile that is longer laterally and posteromedially. Scutellum yellowish brown; densely covered with long, pale yellow setae. Postnotum concolorous with scutum, lightly pruinose. Pleuron densely grayish pruinose anteriorly, often mottled with traces of yellow posteriorly; anepisternal membrane pale brown; mesepimeral tuft pale yellow.

Wing membrane hyaline; veins pale yellow; base of costa; stem vein, and rest of fine setae on veins pale yellow; fringe of calypter and anal lobe pale yellow. Knob of halter yellow, stem mostly brown with pale yellow pile.

Foreleg yellow except tarsus black; midleg yellow except coxa, tip of basal 2 or 3 tarsomeres and apical tarsomeres black; hind leg mostly black except varying amounts of femur, basal $\frac{1}{2}$ of tibia, basal $\frac{4}{5}$ of hind basitarsus, and basal $\frac{1}{2}$ of second hind tarsomere which are yellow; hind basitarsus slender, varying from 5.6 to 7.5 (av 6.4) times as long as broad. Calcipala short, bluntly rounded apically, reaching about $\frac{1}{2}$ distance to pedisulcus; pedisulcus broad and deep but not conspicuous. Legs with mostly pale yellow setae but some of longer setae on posterior margin of hind tibia and tarsus brownish, and dark portions of tarsomeres with black setae.

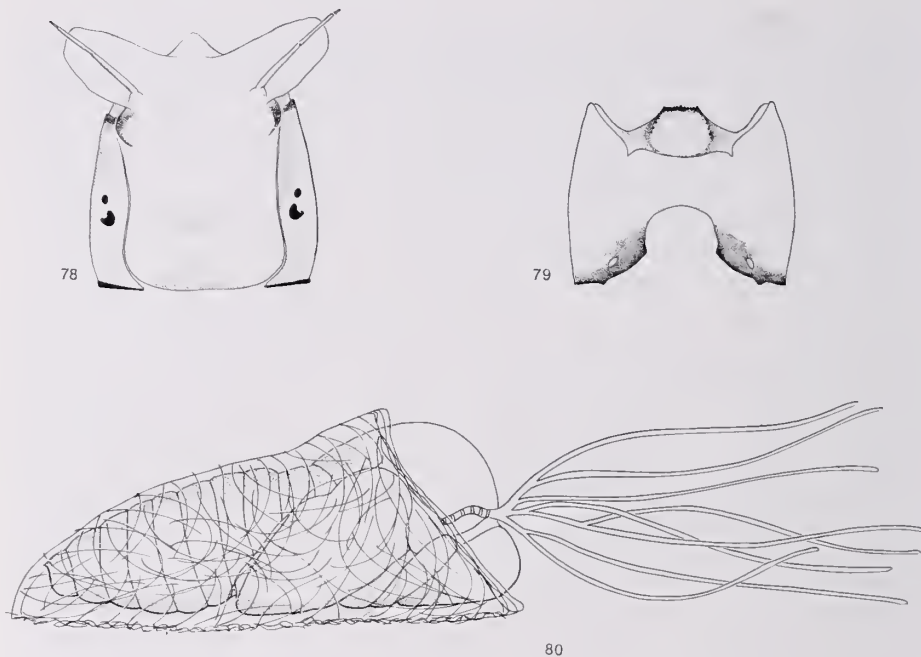
Abdomen, in alcohol preserved specimens, largely black dorsally, more yellow laterally and ventrally; basal scale black, with a fringe of long pale yellow pile; tergites 2 and 6 mostly yellow but each with a median black spot; tergites 3–5 and 8–9 black, tergite 7 with lateral $\frac{1}{3}$ of each side yellow. In dried specimens, tergites black except most of tergites 2 and 6 densely grayish pruinose contrasting with other tergites, lateral marginal areas of tergites 7 and 8 similarly grayish pruinose; sparsely covered with short, black setae dorsally, but with longer pale yellow setae on lateral marginal areas; tergite 10 small, about 2.5 times as long as broad; sternite 1 moderately large, subtriangular, posterior margin rounded, sclerotized; sternite 2 membranous, sternites 3–8 subequal, subquadrate, pale yellowish, with pale yellow setae.

Terminalia as in Figure 76. Gonocoxite, at most, slightly longer than greatest width, subrectangular but slightly tapered distally, sparsely covered with pile on apical $\frac{1}{2}$; distinctly longer than gonostylus. Gonostylus short and subrectangular, varying from slightly longer than greatest width at base to length and width being equal; apical margin, except for inner distal process, nearly straight or with outer distal corner rounded, and with a slight, medial concavity, and inner distal corner produced as a strong, but short, slender process bearing a single, small, nipple-like, terminal spine. Ventral plate of aedeagus, in ventral view, triangular, broadest at junction with basal arms, strongly tapered distally to an acute median point (Fig. 76a shows ventral plate with apex tilted inwardly (dorsally) so that it appears more rectangular), overall length equal to greatest width, length of body proper (from apex to junction with basal arms) $\frac{1}{2}$, or slightly more, of greatest width; proximal margin between basal arms concave; basal arm short, tip slightly curved inwardly, heavily sclerotized, broadly rounded; in lateral view, without a ventral lip so ventral face is distinctly convex; distal margin between basal arms with a long, clear, membranous structure; dorsal

and ventral surfaces densely covered with short setae, those on ventral surface longest; median sclerite of aedeagus long, longer than body of ventral plate, stem very short, arms more than 4 times as long as stem, broadened distally, with a broadly rounded umbrellalike hood whose outer, distal margin is lightly but distinctly sclerotized except for opening of gonopore. Aedeagal membrane with a series of irregular clusters of minute setulae. Plate of endoparameral organ small, subquadrate to subtriangular, with a series of ridgelike cuticular thickenings; arm slender, sharply bent medially and then dorsally, bearing a series of numerous, poorly defined teeth, basal 3 or 4 teeth shorter, stouter and more distinctly defined.

PUPA. Length 2.4–3.6 (av 3.0) mm. Respiratory organ (Fig. 80) 1.4–2.3 (av 1.9) mm, filaments often broken but usually about $\frac{1}{2}$ – $\frac{3}{4}$ as long as pupa; consisting of a short, slender base covered with minute spicules, and with 8 filaments arranged in 3 groups, all on short primary trunks, branching (2+1) + (1+2) + (2) (d-v), paired filaments of mediolateral group on a longer secondary petiole; filaments branching somewhat fanlike so that all are visible in lateral view, and are noticeably more slender than those of other species in this group; filaments pale yellow, with numerous fine, closely placed annulations. Integument of head and dorsum of thorax moderately covered with distinctly raised granules; antennal sheath of male reaching about $\frac{1}{2}$ distance to hind margin of head; antennal sheath of female short of reaching hind margin of head by about $\frac{1}{6}$ length of antenna; clypeus with 1 submedian seta just medial and ventral to base of antenna, frons with 3 short setae at extreme edge near level of first flagellomere of antenna. Dorsum of thorax usually with 4 dorsal and 2 more ventrolateral trichomes that are long, pale, and simple but often 1 dorsal trichome forked. Chaetotaxy of each lateral half of tergites as follows: tergite 1 with 2 short lateral setae; tergite 2 with 4 short, hooklike setae; tergites 3 and 4 with 4 stout, anteriorly directed spines along posterior margin; tergite 5 bare; tergites 6–9 each with a row of short, fine, posteriorly directed spinules near anterior margin, sometimes those of 6 reduced in number; this row on each half of tergites 6–7 separated by a median gap but those of 8–9 complete; this spine row of tergite 7 continuous laterally with a few much smaller, comblike spinules; caudal spines very short, shorter than those of other species of this group; each situated on a faint convexity, straight, tips subparallel to slightly divergent. Chaetotaxy of each lateral half of sternites as follows: sternite 3 sometimes with 1 very small, submedian seta; sternite 4 with 2 small, slender, sublateral hooks; sternites 5–7 each with 2 longer, stouter hooks, those of 5 sublateral and closer together while those of 6–7 more separated but lateral hooks not lying in pleural membrane; sternites 8–9 bare. Cocoon slipper-shaped, tightly but rather coarsely woven so that there often are distinct thicker and thinner areas, anterior rim slightly thickened; in lateral view, anterior margin of cocoon nearly straight but variably slanting anteromedially; anteroventral corners of cocoon variably produced inwardly and, at times, they meet or nearly so to produce an anteroventral collarlike lip or rim; floor extended anteriorly about $\frac{1}{2}$ length of cocoon. In material available for study cocoon unusually stiff and brittle and easily broken, seemingly more so than in any other species of this group.

LARVA. Length 4.2–4.8 (av 4.5) mm. Body color rather uniformly pale grayish white to pale yellowish white; intersegmental lines rather broad, slightly lighter than rest of abdomen. Head capsule (Figs. 78, 79) pale whitish yellow strongly contrasting with dark brown of postocciput, mandibular phragma and hypostoma, and with a



Figs. 78–80. *Simulium venator*. 78. Head capsule of larva, dorsal view. 79. Head capsule of larva, ventral view. 80. Cocoon and pupa, lateral view.

narrow brown band over small eye spots; dorsal head spots mostly not discernible, sometimes a faint brownish cast occupies posteromedian portion of frontoclypeal apotome, sometimes a vaguely H-shaped brownish area present between antero-median and posteromedian spots, anterior $\frac{1}{2}$ or more of frontoclypeal apotome whitish or colorless and transparent. Antenna slightly longer than stalk of labral fan, with a faint brownish tinge on upper $\frac{1}{2}$ of segments, lower $\frac{1}{2}$ transparent; proportions of segments (basal to apical) 10:20:19. Labral fan with about 36 primary rays. Hypostoma with median and outer lateral teeth nearly equal in height and only slightly longer than sublateral teeth; with 0–2 small, weak paralateral teeth; and 2–3 short, weak lateral serrations. Hypostomal cleft moderately deep, extended distinctly more than $\frac{1}{2}$ distance to base of hypostoma. Hypostomal bridge slightly shorter than hypostoma. Mandible with 6 apical teeth 3 of which are weakly sclerotized, and with a relatively long, heavily sclerotized, toothlike process projecting dorsally at about 90° from near base of apical teeth; inner subapical ridge with 1 irregular apical serration and sometimes with a second smaller serration near its base. Maxillary palpus about 3.5 times as long as width at base. Lateral plate of proleg broad, lightly sclerotized, triangular shaped, extended nearly full length of apical segment; circlet of apical hooks in about 35 rows. Anal setulae present but minute and difficult to see, sparse and concentrated in area between anterodorsal and posteroventral arms of anal sclerite; anal papillae with 3 simple lobes, bases of outer and median lobe

narrowly separated, outer lobes strongly divergent from median lobe. Arms of anal sclerite broadly joined medially, anterodorsal arm moderately sclerotized with inner margin more heavily sclerotized, rather pointed apically, about $\frac{2}{7}$ as long as posteroventral arm which is slender, tapered and heavily sclerotized. Posterior circlet of hooks consisting of 12–14 hooks in 75–80 rows. Ventral tubercles small, hardly noticeable.

REMARKS: This species is very similar to *mediovittatum* and, as can be seen from the listed synonymy, some authors considered the two species to be conspecific. However, the female of *venator* is easily separated from that of *mediovittatum* by the slender, pointed, ventral digitiform process of the anal lobe (Fig. 77). In *mediovittatum* the anal lobe is short, more quadrate, and has only a short pointed process (Fig. 43). The males can be separated by the features listed in the key. The larval description is based on a small number of mature larvae and so the integrity of the characters mentioned can not be substantiated.

The holotype female is mostly in good condition. However, the eyes are collapsed, and the left side of the thorax is somewhat obscured by the glue that attaches the specimen to a paper triangle on its pin. The abdomen was removed and mounted on a slide, probably by Dyar. Unfortunately, the abdomen was not dissected, but mounted whole and is flattened and rather badly damaged so the majority of the genital features are almost totally obscured, except for the genital fork which is clearly visible. However, if the slide is turned over and viewed from the underside, the ventral digitiform process of one of the anal lobes is faintly visible, enough to confirm that it is present, which is sufficient to distinguish it from *mediovittatum*. Of the four labels on the pin of the holotype, the uppermost label reads, "Reno Nevada July 7, 1916." The next lower label reads, "H Dyar coll." The next to bottom label simply says, "slide," and the bottom label is a red label that reads, "Type No. 28343 U.S.N.M." The type number is somewhat blotched but readable. The label on the slide with the female abdomen reads, "*Simulium venator* D. & S. Reno, Nev. July 7, 1916, H.G. Dyar." This is followed by the word "Paratype" which has a line through it, and along the bottom of the label is printed "Type No. 28343 U.S.N.M." Also, in the upper right hand corner is the "Q" symbol in pencil.

The holotype female of *beameri* is also glued to a paper triangle attached to a pin. The specimen is in reasonably good condition except that the eyes are collapsed, the thorax is rather greasy, and the left wing has a longitudinal tear just below the costa. The abdomen was removed and mounted on a slide, presumably by Stains or Knowlton. The upper label on the pin reads, "Lone Pine, Cal. VII-28-40 R.H. Beamer." This is followed by the next lower label which is small and bears only the number "36." The bottom label is somewhat aqua-blue-green in color and reads, "*Simulium beameri* n.sp. G.S.S. and G.F.K. Holotype."

When the holotype of *beameri* was borrowed, it was missing the genitalia and no slide or other preparation was found at UKaL. Fortunately, W. J. Hanson found slides with both the female and male terminalia, as well as three other slides bearing the missing terminalia of other species of black flies at Utah State University where Stains and Knowlton worked when *beameri* was described. Each of these slides has a conspicuous bright red star affixed to it. Unfortunately, the terminalia were mounted in a material that has crystallized (possibly Hoyers) and is difficult to see through.

The slide bearing the female genitalia of *beameri* allows just enough visibility to make out the digitiform process of the anal lobe which matches that of *venator*. The genital fork is also visible but is obscured by the crystallized mounting medium. The slide bearing the terminalia of the male allotype is in good condition and the parts are clearly visible. They agree in all respects with those of *venator* thus cementing the synonymy of *beameri* with *venator*. Two slides bearing male terminalia are also present in the USNM collection. One of these is labeled as a paratype of *beameri*, with a pencil notation that this specimen might be *notatum*. The non-paratype slide also is labeled as *beameri* and has a pencil notation that it equals *notatum*. These two specimens are *venator*. It is not likely they could be *notatum* since they are from different localities and have different collection dates, and the male of *notatum* from the type locality (or any other locality) is not known. The slides that Dr. Hanson located were sent to the USNM on permanent loan. However, they will be returned to UKaL to be housed with the rest of the holotype and allotype specimens.

SPECIMENS EXAMINED (total—138 males; 351 females; 41 pupae and pupal skins; 392 larvae): CALIFORNIA: *Inyo Co.*, May 18–September, (A) (includes paratypes of *beameri*). *Mono Co.*, July, (A). *San Bernardino Co.*, May 4–June, (A). *Tulare Co.*, July 28, (A). *Yolo Co.*, October, (A). IDAHO: *Bingham Co.*, July 26–September 8, (A). *Bonneville Co.*, July 18, (A). *Elnore Co.*, May 10–August 9, (A). *Gooding Co.*, September 9–23, (A). *Latah Co.*, June 16, (A). *Owyhee Co.*, August 4, (A). *Twinn Falls Co.*, August 6, (A). *Washington Co.*, September 2, (A). MONTANA: *Yellowstone Co.*, June 22, (A). NEVADA: *Clark Co.*, May 4, (A). *Elko Co.*, June 13–27, (A). *Humboldt Co.*, April 26–July 11, (A, P, L). *Lander Co.*, May 26–June 1, (A, P, L). *Lyon Co.*, August 4, (A). *Washoe Co.*, June 30–October 17, (A, P, L) (includes paratypes). OREGON: *Baker Co.*, September 2–December 13, (A). *Malheur Co.*, September 19, (A). UTAH: *Washington Co.*, March 3, (A). WASHINGTON: *Kittitas Co.*, July 22, (A). *Yakima Co.*, May 19–August 27, (A). WYOMING: *Yellowstone National Park*, July 21–August 4, (A). *Sublette Co.*, Pinedale, June 30–July 1, (A).

PREVIOUS RECORDS: U.S.: California, Idaho, Montana, Nevada, Oregon, Utah.

BIOLOGICAL NOTES: Little is known about the biology of *S. venator*. Like other species of the subgenus *Psilopelmia*, the immature stages usually occur on trailing vegetation in small to medium sized streams with clear and cool to relatively warm water. The females have been reported to feed on horses, and as reported by Knowlton (1935), "... this fly was usually found attacking the skin around the horse's nostrils and eyes or entering the ears." Twinn (1938) mentioned that he had seen two females that were "on horse with brain fever," collected in Lewiston, Utah, August 6, 1937. Some specimens in the USNM collection, from the state of Nevada, bear labels stating, "ex humans," and "off man and dog."

Simulium (Psilopelmia) labellei, new species

Figs. 81–92, 110–111, 114–115, 118, 120, 144–152

FEMALE. General body color black, densely grayish pruinose. Length: body, 1.9–2.9 (av 2.4) mm; wing, 2.3–2.6 (av 2.5) mm.

Head with frons moderately broad, at vertex about $\frac{2}{3}$ wider than at narrowest point, less than $\frac{1}{2}$ width of head, and slightly wider than long; sparsely covered with moderately long, erect whitish to pale yellowish pile. Clypeus concolorous or slightly

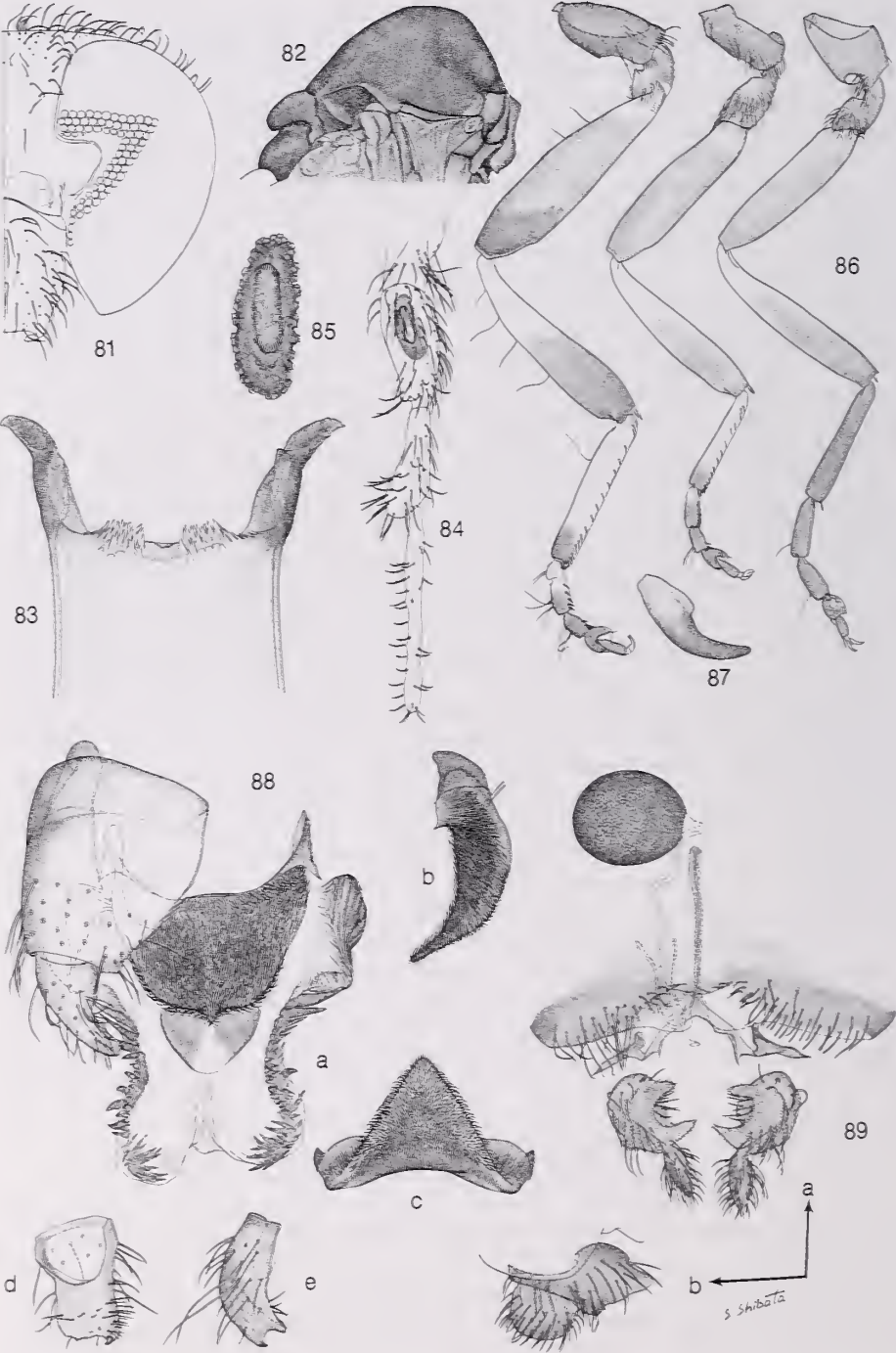
lighter than frons; length and width subequal; sparsely covered with moderately long, whitish to pale yellowish pile interspersed with a few dark setae. Occiput densely covered with long, whitish to pale yellowish pile; postocular setae fine, pale. Scape and pedicel of antenna bright yellow, contrasting with brownish black flagellum; pedicel and 1st flagellomere subequal in length, 1st flagellomere widest; fine pubescence pale yellowish with a few longer dark setae. Mandible with about 42 fine serrations. Blade of maxilla with 27–33 retrorse teeth. Palpus brownish black, distal 2 segments slightly lighter and more brownish than palpomere 3, with black setae; palpomere 5 about $\frac{1}{3}$ longer than palpomere 3. Sensory vesicle relatively large, about $\frac{1}{2}$ as long as its segment, proximally situated, its neck short, arising dorsomedially and extended vertically, with an enlarged, ovoid mouth. Median proximal space of cibarium shallow, broadly U-shaped, with 2 short convexities separated by a shallow median concavity, each convexity with about 17 small denticles that extend part way up rim of dorsolateral arm; dorsolateral arms moderately long, strongly divergent, moderately broad, heavily sclerotized.

Anteprenotal and postprenotal lobes pale yellow to brown, distinctly paler than and usually strongly contrasting with scutum; covered with long, semi-erect to erect, whitish to pale yellow pile. Dorsum of scutum, in lateral view, strongly arched dorsally with high point at about anterior $\frac{2}{5}$; anterior face steeply sloped, posterior face less steeply sloped. Scutum narrowly pale yellowish along lateral margins, and brown anteromedially between postpronotal lobes; anterolateral corner of scutum with a variably distinct, triangular shaped, grayish spot that extends less than $\frac{1}{2}$ height of anterior face of scutum, remainder of scutum densely pruinose except for a moderately wide median strip, lateral margins and posterior declivity which are more lightly pruinose; scutum moderately covered with short, recumbent, pale yellow pile that is longer along lateral and posterior margins. Scutellum strongly triangular, brown, often paler yellowish medially, lighter than scutum, densely covered with long, pale yellow setae. Postnotum slightly darker brownish black than scutellum and more pruinose. Pleuron darker anteriorly, becoming paler medially and posteriorly, often mottled; anepisternal membrane yellowish gray; mesepimeral tuft small, pale yellow.

Wing membrane hyaline; veins pale. Base of costa and stem vein with pale yellow pile, occasionally with a few dark setae; fringe of calypter and anal lobe pale yellow. Knob of halter white, stem brown with pale yellow pile.

Legs: Brown to brownish black, sometimes tinged with yellow. Dorsal surface of fore tibia yellow on about basal $\frac{3}{4}$, apex and ventral surface black; mid- and hind tibiae yellow on basal $\frac{1}{4}$ to $\frac{1}{2}$, remainder dark. Fore tarsus entirely black, basal segment slender, cylindrical; basal segment of mid- and hind tarsi yellow except for a narrow apical ring; second tarsal segments of each leg yellow on basal $\frac{1}{2}$ and dark on distal $\frac{1}{2}$, remaining tarsal segments dark. Hind basitarsus about 6 times as long as broad. Claw simple, slender, short, evenly curved from base.

Abdominal ground color gray dorsally, slightly paler and more yellowish ventrally; basal scale (tergite 1) pale gray on about anterior $\frac{1}{2}$ and dark brown to brownish black on posterior $\frac{1}{2}$, with a fringe of long, whitish to pale yellow pile; tergites 2–6 small, subquadrate, matte brownish black to black, sparsely covered with short, coppery setae; tergite 7 larger, subquadrate but paler brown and densely pruinose; tergites 8–9 of normal shape, concolorous with tergite 7, with sparse pale coppery setae; pleural membrane of segments 2–7 each with a blackish, ventrally directed



band that occupies about anterior $\frac{1}{2}$ of segment and extends ventrally about $\frac{1}{2}$ height of pleural membrane, bands of segments 2 and 3 shorter. Sternites, except 8, broad but weakly sclerotized and nearly indistinguishable; posterior $\frac{1}{2}$ of sternite 8 heavily sclerotized, brownish black to black, with fringelike row of long, dark setae near hind margin.

Terminalia as in Figures 89, 120. Anal lobe narrow dorsally, broadened ventrally at level of lower margin of cercus, at this point nearly as long as high; anterior margin strongly convex, tapered ventrally to a short, setose, digitiform process; posterior margin with a short but conspicuous process just below lower margin of cercus, margin then with a shallow concavity followed by a convexity and then another concavity which culminates in the ventral digitiform process, this process not long enough to cross with process of other anal lobe when in normal position; anal lobe moderately setose especially on posterior marginal area and ventrally. Cercus subquadrate, about as broad as long, hind margin broadly rounded, rather sparsely setose. Hypogynial valve short, not reaching anterior margin of cercus, subtriangular and rounded posteriorly, weakly sclerotized but medial margin slightly more heavily sclerotized; lightly setose basomedially; medial margins of valves diverging posteriorly. Stem of genital fork long, only slightly longer than arm, heavily sclerotized; in lateral view, strongly bowed with arms bent ventrally at almost a right angle to stem; arms strongly divergent; arm long, moderately broad basally, tapered and more slender medially, expanded distally into a subrectangular plate bearing a short, heavily sclerotized toothlike process on anteroventral margin, narrowly attached to segment 9. Spermatheca small, somewhat ovate, heavily sclerotized, without a distinct pattern.

MALE. General body color black, densely grayish pruinose. Length: body, 1.9–2.5 (av 2.2) mm; wing, 1.9–2.4 (av 2.2) mm.

Frons and clypeus densely pruinose, clypeus with erect coppery brown pile. Occiput with long, pale yellow setae. Antenna brownish black, scape and pedicel often paler yellowish brown, rarely yellow; 1st flagellomere slender, slightly longer than pedicel; pedicel distinctly wider than 1st flagellomere; fine pubescence pale yellow. Palpus brown, palpomere 3 more black; with yellowish brown to black pile; palpomere 5 about $\frac{2}{3}$ longer than palpomere 3. Sensory vesicle globular, about $\frac{1}{3}$ as long as its segment; neck distinct, enlarging to form a round mouth.

Postpronotum pale yellow to grayish brown, lighter than scutum; with pale yellow pile. Scutum black, anterior face with a variable grayish pruinose triangular spot just posteromedial to postpronotum, dorsum largely brownish gray pruinose becoming more gray and often less dense on anterolateral face and posterior declivity, lateral margins usually more lightly pruinose; moderately covered with short, recumbent, pale yellow pile that is slightly longer posteromedially. Scutellum brown, distinctly paler than scutum; densely covered with long, pale yellow setae. Postnotum concolorous with scutum. Pleuron black, often becoming slightly paler medially and posteriorly; anepisternal membrane yellowish gray; mesepimeral tuft small, pale yellow.

Wing membrane hyaline; veins pale yellowish gray; base of costa and stem vein

←
Figs. 81–89. *Simulium labellei*. 81. Head of ♀. 82. Female thorax, lateral view. 83. Proximal end of ♀ cibarium showing armature. 84. Palpus of ♀. 85. Female sensory organ, enlarged. 86. Hind, mid-, and fore legs of ♀. 87. Claw of ♀. 88. Male terminalia. 89. Female terminalia.

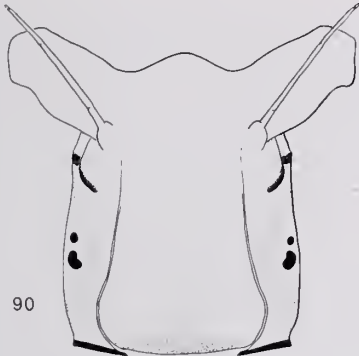
with pale yellow setae some of which may have dark bases; fringe of calypter and anal lobe pale yellow. Knob of halter white, stem brown with pale pile.

Fore leg entirely brownish black except for a slender yellowish streak along ventral surface of tibia. Midleg brownish black except about basal $\frac{1}{4}$ of tibia, basal $\frac{1}{2}$ to $\frac{3}{4}$ of basal tarsomere and basal $\frac{1}{2}$ of second tarsomere which are whitish to yellow. Hind leg brownish black except whitish to yellowish on about basal $\frac{1}{2}$ of tibia, basal $\frac{3}{4}$ of basal tarsomere and basal $\frac{1}{2}$ of second tarsomere; hind basitarsus slender, about 8 times as long as broad.

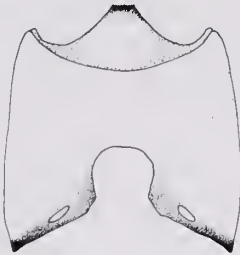
Abdomen matte brownish black dorsally, light gray ventrally; basal scale with a fringe of long pale yellow pile; tergites broad, nearly uniform in width, velvety in texture with paler hind margins; tergite 2 dark centrally, broadly yellowish gray laterally; tergite 6 densely gray pruinose, slightly less dense dorsomedially; hind margins of tergites 7 and 8 grayish pruinose; lateral margins of tergites 2–5 with long, pale yellow pile, tergites sparsely covered with short, pale yellow setae dorsally, these becoming black on tergites 6–9; tergite 10 small, rectangular, about twice as wide as long. Sternites 3–8 subquadrate, small but slightly increasing in size and degree of sclerotization posteriorly, about anterior $\frac{1}{2}$ bare, posterior $\frac{1}{2}$ sparsely covered with short, pale yellow setae.

Terminalia as in Figures 88, 118. Gonocoxite subquadrate, greatest width nearly twice greatest length, setose only on little more than distal $\frac{1}{3}$. Gonostylus short, about $\frac{1}{4}$ longer than greatest width at base; outer apical margin variably rounded, sometimes only slightly produced and sometimes produced as a convexity as long or nearly as long as inner distal corner including single terminal spine, this results in a concavity of somewhat variable depth between them. Ventral plate of aedeagus broad; in dorsal view, somewhat triangular or spade-shaped with a short, ventral lip; in ventral view, broadest at junction with basal arms, tapered distally, apical margin narrow and nearly straight to faintly concave, but with a short, distinct median, ventrally directed, triangular process or lip, if slightly tilted then apex narrowly rounded; proximal margin between basal arms concave; basal arm short, slightly curved inwardly, end broadly rounded, with a short, subapical, posterolaterally directed process; median sclerite of aedeagus relatively long with short stem and long, deeply bifid arms that are broadly rounded distally. Basal plate of endoparameral organ short but broad, wrinkled basally, smooth distally and continuous with broad arm that twists and tapers distally to a more slender process bearing about 4–5 stronger and slightly more distinct basal teeth, and a more distal series of poorly defined teeth; apices of arms joined anteromedially in a broad V-shape, and are continuous with a moderately sclerotized, rodlike fold of aedeagal membrane, this rodlike structure directed anteriorly (internally), but is shorter than that in *robynae*. Aedeagal membrane beset with scattered, minute, mostly single spiniform or rodlike thickenings but with some comblike ridges.

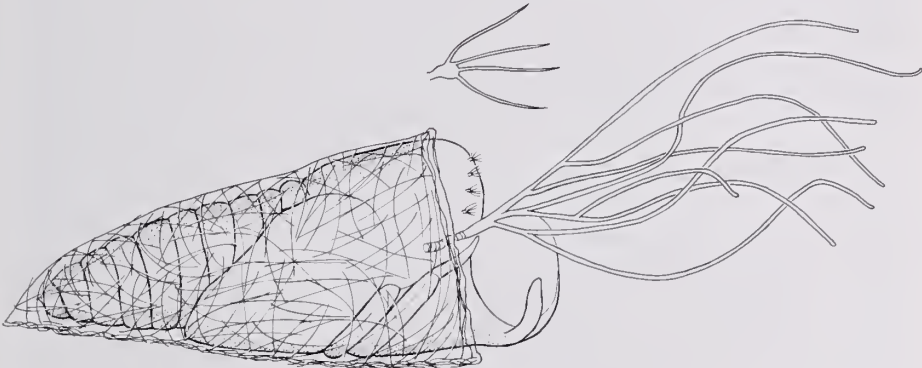
PUPA. Length 2.4–3.0 (av 2.7) mm. Thorax, in lateral view, distinctly separated from head, its anterior face nearly vertical and conspicuously arched well above level of top of head (Fig. 92). Respiratory organ with 8 filaments; 1.9–3.0 (av 2.4) mm long, when complete often as long as pupa, but more frequently broken and shorter than pupa. Branching pattern somewhat variable but most often as follows: base short, rather slender, with very minute spicules; base branches into an outer lateral trunk with 2 filaments, and an inner more dorsal trunk that in turn divides into a



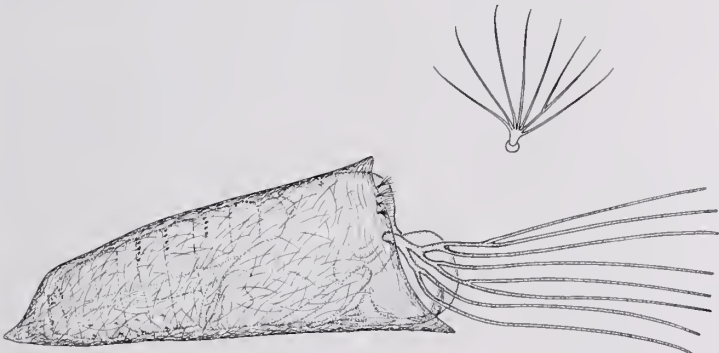
90



91



92



93

Fig. 92

Figs. 90–93. *Simulium labellei*. 90. Head capsule of larva, dorsal view. 91. Head capsule of larva, ventral view. 92. Cocoon and pupa, lateral view, with enlarged view of a thoracic trichome. *Simulium robynae*. 93. Cocoon and pupa, lateral view, with enlarged view of a thoracic trichome.

dorsomedial trunk branching 2+1 (dorsal-ventral) and a medioventral trunk branching 1+2; filaments slender, whitish to pale yellowish, with fine, shallow annulations. Integument of head and dorsum of thorax much as in *robynae* with faintly raised granules but which are more numerous and closely placed on the head, and less so on thorax so that thorax appears more glossy; antennal sheath of male reaching about $\frac{1}{2}$ distance to hind margin of head; antennal sheath of female not reaching hind margin of head by about length of 2 antennomeres; clypeus with a pair of pale setae medial and ventral to bases of antennae, other setae not visible on specimens at hand. Anterolateral face of thorax with a series of 4 tuftlike trichomes, each with a short stout base that gives rise to 4–12 or more slender, pale branches, often arranged fanlike, that may be long enough to overlap those adjacent to it; a similar trichome is situated just posterior to base of respiratory organ and another just anterior to anteroventral angle of wing sheath; dorsal surface of thorax, above level of respiratory organ, usually with 2 fanlike and 1–3 long, simple trichomes on each side. Chaetotaxy of each lateral half of abdominal tergites as follows: tergite 1 with 1 long, sublateral seta; tergite 2 with a posterior row of 4 small, hooklike setae sublaterally and with 1 or 2 similar setae at edge of tergite; tergites 3 and 4 each with 4 anteriorly directed spines along posterior margin and with 1 seta just anterior to this row of spines and 2 or 3 similar setae along lateral edge of tergite; tergites 5–6 essentially bare; tergites 7–9 each with a row of short, fine, posteriorly directed spinules near anterior margin, those of tergites 7 and 9 with broad gap medially, but that of tergite 8 complete or with a narrow medial gap; caudal spines short, each situated on a slightly swollen convexity, these spines straight, tips slightly convergent. Chaetotaxy of each lateral half of sternites as follows: sternite 3 with 1 lateral seta; sternite 4 with 1 small, slender, submedian hook and 1 medial and 1 lateral seta; sternites 5–7 each with 4 longer, stouter hooks, those of 5 submedian and close together, lateral hooks of sternites 6–7 placed near lateral edge of sternite; sternites 8–9 bare. Cocoon yellowish gray, slipper-shaped with a low profile, densely woven, anterior edge not thickened nor reinforced, or only weakly so, and thus often somewhat irregular; in lateral view, anterior margin of cocoon nearly straight, only slightly slanting anteroventrally; floor often extended full length of cocoon, but fragile and easily damaged.

LARVA. Length 4.2–5.2 (av 4.7) mm. Body color brownish yellow, slightly more brownish posterodorsally, and more whitish ventrally; intersegmental lines narrow, slightly darker than rest of abdomen; abdomen widest at junction of segments 6 and 7 then rather strongly tapered to posterior circlet of hooks so that abdomen is somewhat bluntly pointed posteriorly. Head capsule (Figs. 90, 91) pale yellow to brownish yellow, only postocciput, mandibular phragma and eye spots dark brown to black; posterior margin of frontoclypeal apotome sometimes with a small, median, brown triangular spot, and upper margins of postgenae above eye spots sometimes brownish, otherwise head spots, at most, faintly distinguishable; frontoclypeal apotome transparent whitish anterior to level of mandibular phragma except anterior margin narrowly brownish. Antenna slender, almost transparent whitish and often difficult to see clearly, slightly but distinctly longer than stalk of labral fan; proportions of segments (basal to apical) 7:9:9. Labral fan with about 75–82 very fine primary rays. Labrum clothed with short erect setae. Hypostoma with distal margin slightly concave, median and outer lateral teeth nearly equal in height, sublateral teeth very small but distinct, paralateral teeth represented by 2 slight convexities, and with 3

lateral serrations that also are weak but better developed than paralateral teeth; with 5 subequal but very slender, pale hypostomal setae on each side and 1 smaller sublateral setae near hind margin, these setae difficult to see except under high magnification. Hypostomal cleft somewhat U-shaped, anterior margin difficult to discern, shallow; Hypostomal cleft, hypostomal bridge, and hypostoma all subequal in length. Mandible with 6 apical teeth, dorsal process arising near base of these teeth heavily sclerotized, rather broad and rounded distally in one view, and slender and pointed in another; with about 9 combteeth; inner subapical ridge with 1 small, fine serration. Maxillary palpus nearly parallel sided, tapered only slightly, about 4 times as long as width at base. Lateral plate of proleg relatively broad, irregular but somewhat triangular in shape, extended nearly full length of apical segment, lightly sclerotized and often difficult to see; circlet of apical hooks in about 34 rows. Anal setulae apparently absent; anal papillae consisting of 3 simple lobes whose bases are set close together, lateral lobes rather straight, not strongly divergent from median lobe, all 3 lobes often projecting anteriorly more so than in most other species. Anterodorsal arm of anal sclerite slender, weakly sclerotized, subequal in length to posteroventral arm which also is slender but heavily sclerotized, arms broadly but weakly joined medially. Posterior circlet of hooks narrower than in most other species, consisting of about 20–24 minute hooks in about 110–116 slender rows. Ventral tubercles present but small and inconspicuous.

HOLOTYPE. Female, Presidio, *Presidio Co.*, TEXAS, January 12, 1949 (collector unknown).

PARATYPES. 10 ♂♂, 11 ♀♀, 2 pupae, 3 larvae, same data as holotype; 1 ♀, 1 ♂, same data except January 26, 1944, J. H. Russell; 1 ♀, 29 mi south Marathon, *Brewster Co.*, TEXAS, April 12, 1949, Michener and Beamer; 3 ♂♂, 3 ♀♀, Del Rio, *Val Verde Co.*, TEXAS, December 15, 1963, R. B. Eads, light trap. 1 ♂, same data except December 20, 1963. 5 ♂♂, 2 ♀♀, same data except February 1964. 1 ♀, MEXICO (no other data), January 13, 1940. Holotype and paratypes deposited in the U.S. National Museum of Natural History, Washington, D.C.

DEDICATION. This unusual species is dedicated to Robert Labelle, of Toronto, Ontario, Canada, who is a very unusual and distinctive man in the most positive sense, and who has been and remains a very choice friend.

REMARKS. Structurally, this species is similar to *S. robynae* n. sp. in the highly arched dorsum of the thorax and the terminalia of both sexes. However, adults of *labellei* are almost entirely black and somewhat larger than *robynae* whose adults are predominantly orange and smaller. The two species can be separated by the characters given in the keys.

The noticeable highly arched thorax of both sexes, and the similar form of the pupal thorax with the series of 4 stout, multibranched trichomes on each anterolateral margin immediately separates both of these species from all other North American species. It must be noted here that the pupal and larval descriptions were based on just a few specimens from the type locality, Presidio, Texas. All of these specimens were dissected for the descriptions and illustrations and therefore the descriptions may need some revision when additional material is available for study.

BIOLOGICAL NOTES. Almost nothing is known about the biology of this interesting species. Most of the available specimens were collected in light traps, and several females have blood in the abdomen which indicates that they probably feed

on horses or cattle, or both. All available specimens were collected during the winter months of December, January and February, with only one collection made in April. However, this may reflect the activities of the collectors, not the seasonal distribution of the species. This species and the following species both occur in Del Rio, Texas, and probably live in the same or similar habitats, and have similar habits.

***Simulium (Psilopelmia) robynae*, new species**

Figs. 93–109, 112–113, 116–117, 119, 121

Simulium ochraceum Walker, Cockerell, 1897:100 (on horse) (misidentification).

Simulium notatum Adams, Malloch, 1914:32 (♀, ♂, description, key, catalog, plate 5, fig. 6) (♀ only; ♂ identity unknown; misidentification); Dyar and Shannon, 1927: 36 (♀, ♂, description, key, figs. 88–89) (♀ only; ♂ identity unknown; misidentification).

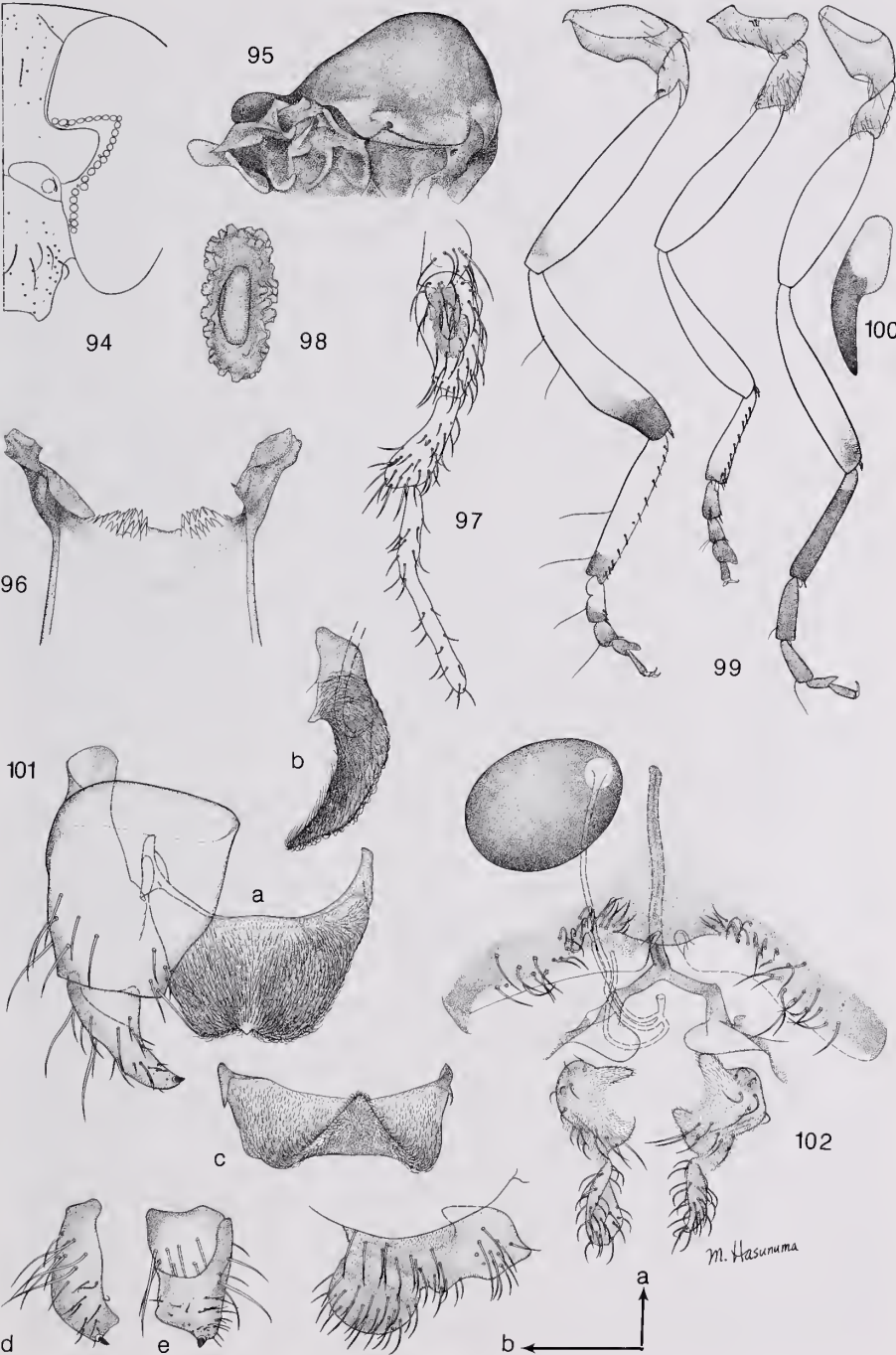
FEMALE. General body color varying from orange, orange with a blackish tinge to black with an orange tinge, and grayish pruinose. Length: body, 1.5–2.1 (av 1.8) mm; wing, 1.9–2.1 (av 2.0) mm.

Head black. Frons moderately broad, at vertex slightly less than $\frac{1}{2}$ as wide as at narrowest point, less than $\frac{1}{2}$ width of head, and length and greatest width nearly equal; moderately covered with relatively long, decumbent, whitish to faintly yellowish pile. Clypeus concolorous with or more yellowish brown than frons; length and width subequal; moderately covered with relatively long, whitish to faintly yellowish pile. Occiput densely covered with long, whitish to faintly yellowish pile; postocular setae pale. Antenna with scape, pedicel and basal $\frac{1}{2}$ or more of 1st flagellomere yellow, rest of flagellum varying from entirely (or nearly so) yellow, to more yellowish brown to black; pedicel and 1st flagellomere nearly equal in both length and width; fine pubescence pale yellow. Mandible with about 30 minute serrations on inner margin and about 3–10 weak, poorly defined serrations on outer margin. Blade of maxilla with 22–27 retrorse teeth. Palpus pale yellowish brown to black, distal 2 segments slightly lighter and more yellowish than palpomere 3; with pale yellow setae admixed with some dark setae; palpomeres somewhat variable in length, palpomere 5 varying from twice as long to only $\frac{1}{2}$ longer than palpomere 3. Sensory vesicle slightly more than $\frac{1}{2}$ as long as its segment, proximally situated, its neck short, arising anterodorsally and extended vertically, with an enlarged ovoid mouth. Median proximal space of cibarium shallow, broadly U-shaped, with a central concavity between 2 low, sublateral lobes each bearing about 6–9 weak, ill defined denticles; dorsolateral arm short, rather broad, outwardly curved, and moderately sclerotized.

Thorax ranging in color from orange, to brownish orange to black; antep pronotum, postpronotum and scutum concolorous, each covered with long, pale yellow pile. Scutum strongly arched; in lateral view, anterior face nearly vertical, highest point situated just anterior to midlength of scutum, posterior portion less strongly sloping; scutum, in anterior view, rather uniformly pruinose except for a sublateral stripe on

→

Figs. 94–102. *Simulium robynae*. 94. Head of ♀. 95. Female thorax, lateral view. 96. Proximal end of ♀ cibarium showing armature. 97. Palpus of ♀. 98. Female sensory organ, enlarged. 99. Hind, mid-, and fore legs of ♀. 100. Claw of ♀. 101. Male terminalia. 102. Female terminalia.



each side and extreme lateral margins which are more grayish pruinose, lateral margins slightly paler in color; anterolateral corner of scutum with a small, variably distinct triangular, grayish spot; scutum rather densely covered with short, recumbent, pale yellow pile which is longer along anterior and lateral margins and still longer posteromedially. Scutellum varying from yellow to black, when yellow then paler than scutum; densely covered with long, pale yellow setae. Postnotum orange brown to black, moderately grayish pruinose. Pleuron concolorous with scutum, usually uniform in color and pruinosity, sometimes slightly paler and mottled medially and posteriorly, anterior margin nearly vertical, curved posteriorly at katapisternum; anepisternal membrane slightly more pale; mesepimeral tuft small, pale yellow.

Wing membrane hyaline; veins yellowish; base of costa and stem vein with pale yellow pile; fringe of calypter and anal lobe pale yellow. Halter yellow, stem sometimes tinged with brown, with pale pile.

Legs: Foreleg yellow except for tarsus which is black. Midleg yellow except for distal 2 tarsomeres which are black. Hind leg yellow except for apices of tibia, basitarsus, second and sometimes third tarsomeres, and distal 2 tarsomeres which are black; in black specimens, black of legs may be somewhat more extensive; hind basitarsus slender but varying from 4–7 times as long as broad; calcipala short, not reaching pedisulcus; pedisulcus small, moderately deep. Claw short, evenly curved from base, simple.

Ground color of abdomen in all but black form brownish yellow, becoming paler yellow ventrally; abdomen brownish black in black form. Basal scale (tergite 1) yellow, with a fringe of long, pale yellow pile; tergites 2–6 small, subquadrate, matte brownish black, tergites 7–9 broader, paler grayish yellow to brownish; pleural membrane of segments 3–6 each with a darker grayish mark that extends ventrally about $\frac{1}{4}$ – $\frac{1}{3}$ distance to sternites; sternites lightly sclerotized, pale yellow, barely discernible, sparsely setose.

Terminalia as in Figures 102, 121. Anal lobe narrow dorsally, broadened ventrally at level of ventral margin of cercus where it is produced posteriorly as a slight but distinct convexity and is continuous ventrally with a distinct concavity and a short, moderately broad, digitiform process; anterior margin of anal lobe below tergite 9 strongly, and broadly convex then tapered to digitiform process; greatest length about equal to height from ventral tip of digitiform process to lower margin of cercus; posterior margin not produced beneath cercus; moderately setose. Cercus subquadrate, slightly higher than long, hind margin strongly rounded, moderately setose. Hypogynial valve short, in normal position not reaching digitiform process of anal lobe; valve subtriangular, narrowly rounded to slightly pointed posteriorly, medial margin lightly sclerotized, convex, narrowly separated from one of other side, sparsely setose on basal $\frac{1}{2}$. Stem of genital fork long, heavily sclerotized, about $\frac{2}{3}$ longer than arms; in lateral view, bent ventrally at nearly a right angle at point of origin of arms; arms moderately long, diverging in a broad V-shape, curved posteriorly at about $\frac{1}{2}$ length of arm, expanded distally into a subrectangular plate with a short, sclerotized toothlike process directed dorsally to anterodorsally on anteroventral margin, arm narrowly attached to segment 9. Spermatheca small, elongate, heavily sclerotized, with a loose reticulate pattern.

MALE. General body color black, lightly grayish pruinose. Length: body, 1.4–2.0. (av 1.7) mm; wing, 1.3–1.7 (av 1.5) mm.

Frons and clypeus lightly to moderately gray pruinose; clypeus with long, pale yellow pile. Occiput with long, pale yellow setae. Antenna brownish yellow, scape and pedicel paler yellow; pedicel and first flagellomere nearly equal in length; fine pubescence pale yellow. Palpus black, palpomeres 4–5 more gray, with pale yellow and brownish pile; palpomere 5 about $\frac{2}{3}$ longer than palpomere 3. Sensory vesicle about $\frac{1}{3}$ as long as its segment; neck short, enlarged to form a round mouth.

Anteprenotal lobe, postpronotal lobe and adjacent anteromedian portion of scutum, plus lateral margin of scutum yellow overlain with a grayish pruinosity, anteprenotal and postpronotal lobes with long, yellow pile; remainder of scutum variably orange black to black with a gray pruinosity, and moderately covered with short, recumbent, yellow pile that is longer laterally and posteromedially. Scutellum yellowish brown, paler than scutum; densely covered with long, yellow setae. Postnotum concolorous with scutum. Pleuron black anteriorly, becoming slightly paler medially and posteriorly, and sometimes mottled; anepisternal membrane brownish black; mesepimeral tuft small, pale yellow.

Wing membrane hyaline; veins pale yellow; base of costa and stem vein with pale yellow pile; fringe of calypter and anal lobe pale yellow. Knob of halter bright yellow, stem brown with pale yellow pile.

Foreleg yellow except dorsal surface of tibia which is variably browned, and tarsus which is black. Midleg largely yellow except coxa and dorsal surface of femur which are variably browned, and apex of first 2 tarsomeres and all remaining tarsomeres which are brown to black. Hind leg black except basal $\frac{1}{4}$ – $\frac{1}{3}$ of femur, basal $\frac{1}{2}$ of tibia, and all but apex of basitarsus and basal $\frac{1}{2}$ of 2nd tarsomere yellow; hind basitarsus about 4 times as long as broad. Claw small.

Abdomen largely black but pleural membrane yellowish gray; basal scale with fringe of long pale yellow pile. Tergites matte black, hind margins narrowly yellow to gray, that of tergite 7 more broadly gray, moderately covered with mostly pale yellow setae; tergite 10 small, rectangular, about $\frac{2}{5}$ wider than long; sternites 3, 4 and basal $\frac{2}{3}$ of sternite 5 yellow, posterior $\frac{1}{3}$ of sternite 5, and all of sternites 6–8 black; with mostly pale yellow setae.

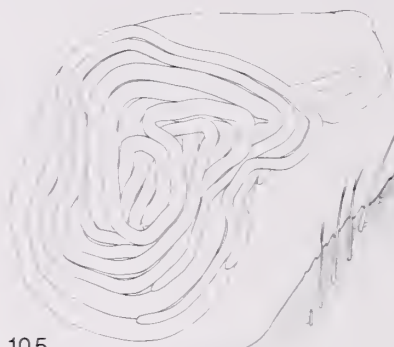
Terminalia as in Figures 101, 119. Gonocoxite subquadrate, slightly longer than greatest width, sparsely setose on all but basal $\frac{2}{5}$. Gonostylus short, about $\frac{2}{3}$ longer than greatest width at base; apical margin with inner distal angle produced as a slender, digitiform process that extends well beyond outer distal angle, with 1 tiny terminal spine, moderately setose. Ventral plate of aedeagus, in ventral view, broadest at junction with basal arms; in one view, tapered distally to a slender, nipplelike, median point that, in another view, is set off by a slight concavity on either side, but distal margin never straight or only faintly concave; marginal area between basal arms concave; basal arm short, pointed apically, moderately sclerotized, straight to faintly bowed outwardly; median sclerite of aedeagus with stem short, arms distinctly longer and deeply separated, broadly rounded distally. Basal plate of endoparameral organ broad, subquadrate, with corrugations; arm moderately broad, bent in a U-shape, bearing about 20 irregular, poorly defined teeth of which 2–4 are longer and better defined; between and joining apex of each arm is a somewhat sclerotized, rodlike thickening of the aedeagal membrane that is directed internally at about a right angle to apices of arms; this thickening lies just dorsal to opening of gonopore and possibly serves as a support to the dorsal surface of the aedeagal membrane. Aedeagal mem-



103



104



105



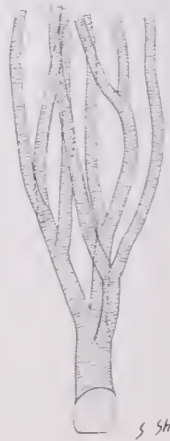
107



106



108



109

S Shibata

brane beset with numerous minute, closely placed, comblike ridges composed of 1 to about 8 rodlike thickenings.

PUPA. Length 2.8–3.00 (av 2.9) mm. Thorax of pupa, in lateral view, distinctly separated from head, anterior face of thorax nearly vertical and projected dorsally well above level of top of head (Figs. 93, 108). Respiratory organ (Figs. 93, 109) with 8 filaments; varying from 1.3–1.6 (av 1.5) mm long (those of the specimens available at least partially broken and greatest length may be somewhat longer than indicated here); branching pattern somewhat variable as to position of 3 main groups of filaments as follows: base of respiratory organ short, slender, covered with minute spicules; base usually giving rise to a dorsal branch with a short, stout petiole that divides into a dorsomedial branch with 3 filaments branching 2+1 (dorsal-ventral), and a more ventromedial branch with 3 filaments branching 1+2 (d-v); and a more ventrolateral branch on a long, slender petiole that divides into 2 filaments; sometimes this latter branch is dorsal in position and the other 2 main groups of filaments take a more ventral position; filaments pale yellow, with numerous narrow, irregular annulations. Integument of head and thorax with numerous, tiny, closely placed granules that are only faintly raised and have a texture similar to that found on a football made of pigskin; antennal sheath of male reaching about $\frac{1}{2}$ distance to hind margin of head; antennal sheath of female short of reaching hind margin of head by about length of 2 antennomeres; clypeus with 2 median setae at about level of base of palpus. Thorax just posterior and dorsal to respiratory organ with row of 4 rather stout, tuftlike trichomes each with about 5–12 branches, and with about 2–3 more posterolateral dorsal trichomes that are long and simple or bifurcate. Chaetotaxy of each lateral half of tergites as follows: tergite 1 with 1 anterolateral and 1 posterolateral seta; tergite 2 with a posterior, submedian row of 3–4 short setae, 2 slightly more anterolateral setae, and 2 more posterior setae along lateral margin; tergites 3 and 4 each with 4 stout, anteriorly directed spines along posterior margin, and 1 more anterior submedian seta and 1 lateral seta; tergites 5–6 essentially bare except for 1 or 2 minute scattered setae, tergite 6 sometimes with a vestige of 1–3 tiny spinules at extreme anterolateral margin; tergites 7–9 each with a row of short, fine, posteriorly directed spinules near anterior margin, those of tergite 7 with a wide median gap, those of tergites 8–9 complete or with a narrow gap medially; caudal spines tiny, straight, tips subparallel to slightly convergent, each situated on a slightly swollen convexity. Chaetotaxy of each lateral half of sternites as follows: sternite 3 with 0–1 very small, anterolateral seta; sternite 4 with 1 small, slender lateral hook; sternite 5 with 2 larger, closely situated lateral hooks; sternites 6–7 each with 2 longer, rather slender, broadly separated hooks, lateralmost hook lying in lateral margin of sternite, sternites 8–9 bare. Cocoon slipper-shaped, yellowish gray, tightly woven but rather transparent; in lateral view, with a low profile, anterolateral margin of cocoon nearly vertical, anteroventral corner projecting only slightly in front of side; floor extended about $\frac{4}{5}$ length of cocoon.

←

Figs. 103–109. *Simulium robynae*. 103. Head capsule of larva, dorsal view. 104. Head capsule of larva, ventral view. 105. Respiratory histoblast of mature larva. 106. Tip of mandible of larva. 107. Hypostoma of larva. 108. Cocoon and pupa, lateral view (not showing thoracic trichoms). 109. Basal portion of respiratory organ of pupa.

LARVA. Length 3.9–4.6 (av 4.3) mm. Body color pale white to yellowish white, segments 6–8 with a touch of reddish brown dorsally; intersegmental lines rather broad, concolorous with rest of abdomen; abdomen noticeably slender on segments 1–4, segment 5 conspicuously widened, remaining segments tapered posteriorly; with a pair of short, posteroventral tubercles. Head capsule (Figs. 103, 104) pale yellowish white, frontoclypeal apotome paler anteriorly and almost transparent, head spots very faintly detectable, hind margin narrowly pale brownish. Postocciput and mandibular phragma contrastingly dark brown, cervical sclerites seemingly absent. Gena, just dorsal to eye spots and just below ecdysial line, with a slender brownish streak; eye spots small, black, sometimes absent. Antenna pale yellowish white, distinctly longer than stalk of labral fan by about $\frac{1}{2}$ or more length of distal antennomere; proportions of antennomeres somewhat variable but about 11:13:16 (basal to apical). Labral fan with about 60–64 primary rays. Hypostoma as in Figure 107; apical margin nearly straight to faintly concave, medial tooth short, about as long as outer lateral teeth; outer lateral teeth short but only slightly longer than sublateral teeth which are very small; paralateral teeth absent; with 2–3 weakly developed, lateral serrations; with 4–5 fine, pale, hypostomal setae. Hypostomal cleft broadly rounded, apex slightly pointed; moderately deep, extended about $\frac{2}{3}$ distance to base of hypostoma. Hypostomal bridge usually slightly shorter than hypostoma, more rarely subequal in length. Mandible with 3 apical teeth with distalmost largest, and 8–11 preapical teeth; outer distal margin with a small, broadly rounded, subconical process that is about as long as greatest width at base; inner subapical ridge with 1 small, distal serration that is much larger than a very minute, proximal serration situated close to base of distal serration, sometimes proximal serration absent. Maxillary palpus slender, about 4 times as long as width at base. Lateral plate of proleg broad, irregularly subquadrate, lightly sclerotized and indistinct, extended about $\frac{3}{4}$ length of apical segment; circlet of apical hooks in about 28–30 rows. Anal setulae absent; anal papillae with 3 simple lobes that are rather sharply pointed apically, and narrowly separated basally. Anterodorsal arm of anal sclerite about $\frac{1}{2}$ as long as posteroventral arm, area between arms heavily sclerotized as a subrectangular block, arm with heavily sclerotized medial ridge and irregular and less sclerotized margins; posteroventral arm heavily sclerotized, slender and distinct. Posterior circlet of hooks consisting of 12–15 hooks in 85–90 rows.

HOLOTYPE. Female, 10 miles west of Del Rio, *Val Verde Co.*, TEXAS, Oct. 13, 1953, H. M. Brundrette.

PARATYPES. 1 ♂, 38 ♀♀, same data as holotype. 3 pupae, 1 pupal pelt, Rio Grande, Big Bend National Park, *Brewster Co.*, TEXAS, March 16, 1954, Coleman. 1 pupa, 4 pupal pelts, 14 larvae, same data. 2 ♂♂ (poor condition), 2 pupal pelts, 16 larvae, same data. 1 ♂, 1 ♀ dissected from pupae, 1 pupa, 2 larvae, same data except March 17, 1954. 1 ♀, reared, Terlingua creek, Big Bend National Park, *Brewster Co.*, TEXAS,

→

Figs. 110–117. *Simulium labellei*. 110. Female head and thorax, lateral view. 111. Male head and thorax, lateral view. *Simulium robynae*. 112. Female head and thorax, lateral view. 113. Male head and thorax, lateral view. *Simulium labellei*. 114. Female thorax, dorsal view. 115. Male thorax, dorsal view. *Simulium robynae*. 116. Female thorax, dorsal view. 117. Male thorax, dorsal view.



110



111



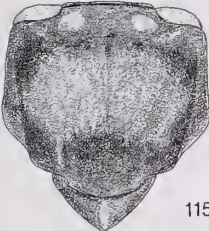
112



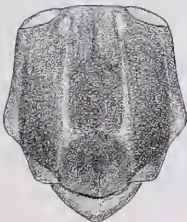
113



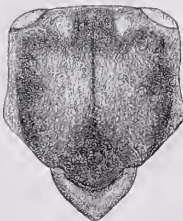
114



115

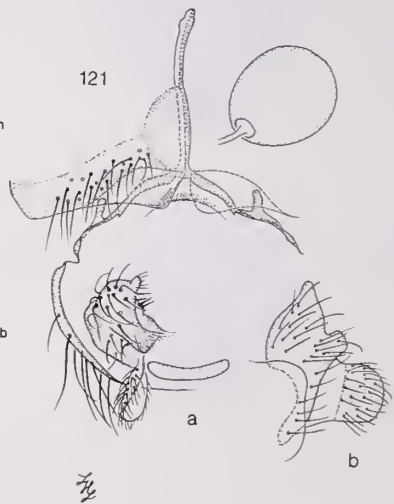
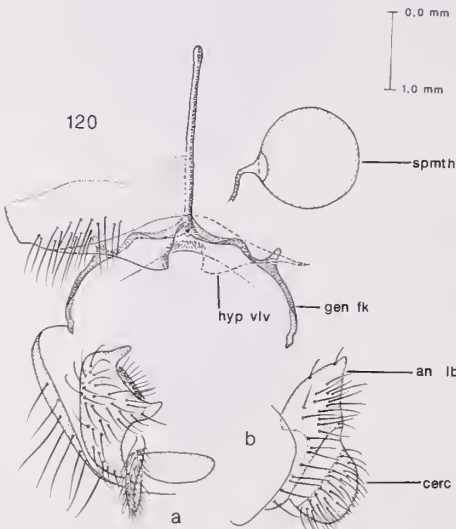
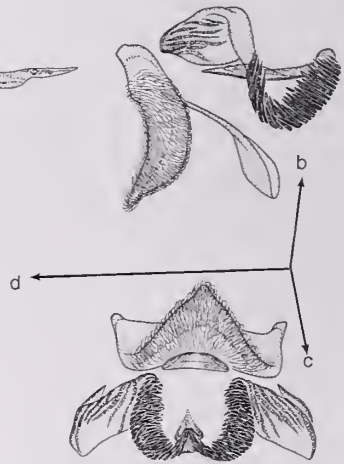
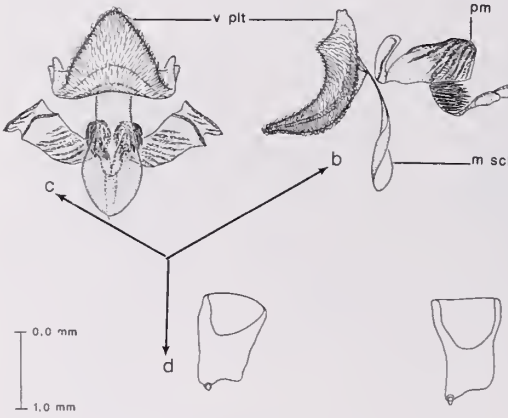
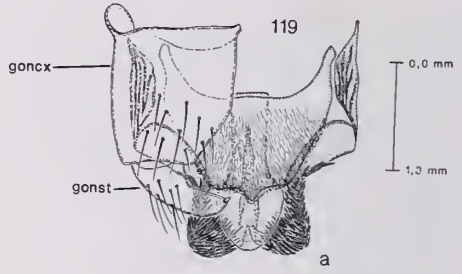
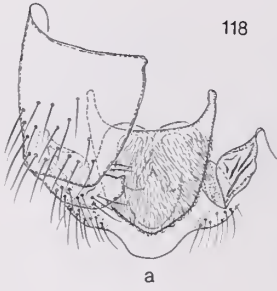


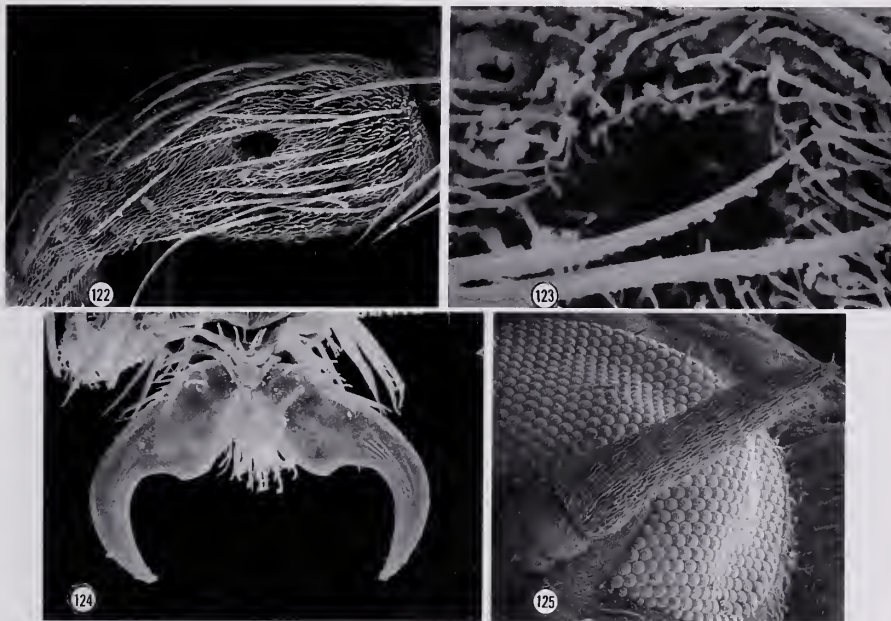
116



117

2/2





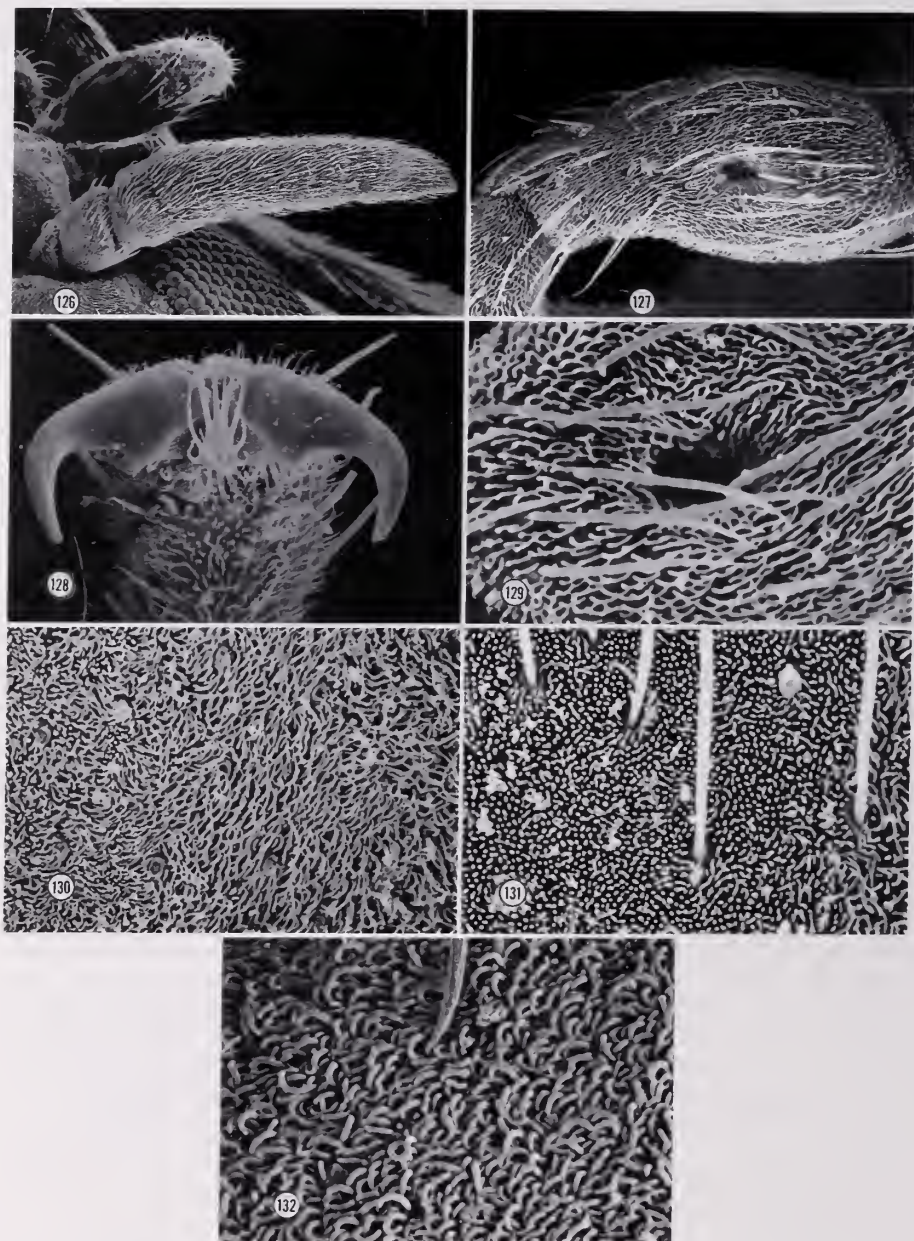
Figs. 122–125. SEM Micrographs. *Simulium griseum*, female. 122. Third palpomere showing mouth of sensory organ (vesicle). 123. Enlargement of mouth of sensory organ. 124. Claws. 125. Portion of head showing eye and antenna.

March 17, 1954, Coleman. 5 pupae, 18 larvae, Grassy Banks picnic area on Rio Grande, approximately 9.5 miles west of Lajitas on Hwy. 170, *Presidio Co.*, TEXAS, May 8, 1991, B. V. Peterson. 15 ♀♀, J. Ramirez Farm, *Presidio Co.*, TEXAS, September 10, 1972, USDA collection, on horse. 3 ♀♀, Davenport Ranch, *Terrell Co.*, TEXAS, June 10, 1965, from ear of jackrabbit. 8 ♂♂, 11 ♀♀, Del Rio, *Val Verde Co.*, TEXAS, September 24, 1963, R. B. Eads, light trap. 17 ♂♂, 11 ♀♀, same data except October 4, 1963. 20 ♂♂, 16 ♀♀, same data except July 1964. 1 ♀, Devil's River, *Val Verde Co.*, TEXAS, May 6, 1907, Bishopp and Pratt, at light (misidentified as *S. notatum* Adams by Malloch (1914). 2 ♀♀, Las Cruces, *Doña Ana Co.*, NEW MEXICO, June 25, 1895, Cockerell (originally identified by Cockerell as *S. ochraceum* Walker, and later as *S. notatum* by Malloch). Holotype and paratypes deposited in the U.S. National Museum of Natural History, Washington, D.C.

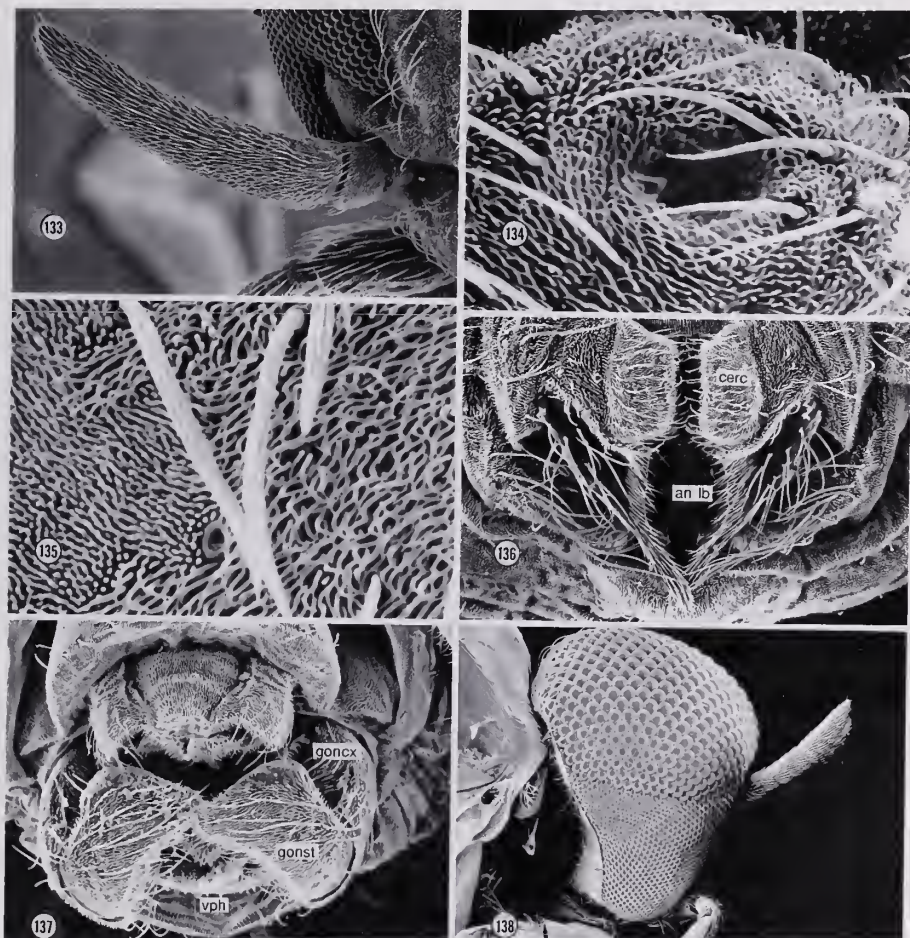
DEDICATION. This small, colorful species is named in honor of my youngest daughter Robyn who is colorful in her own right and who has brought much joy, enthusiasm, and uncommonly good sense into our home.

←

Figs. 118–121. *Simulium labellei*. 118. Male terminalia. *Simulium robynnae*. 119. Male terminalia. *Simulium labellei*. 120. Female terminalia. *Simulium robynnae*. 121. Female terminalia.

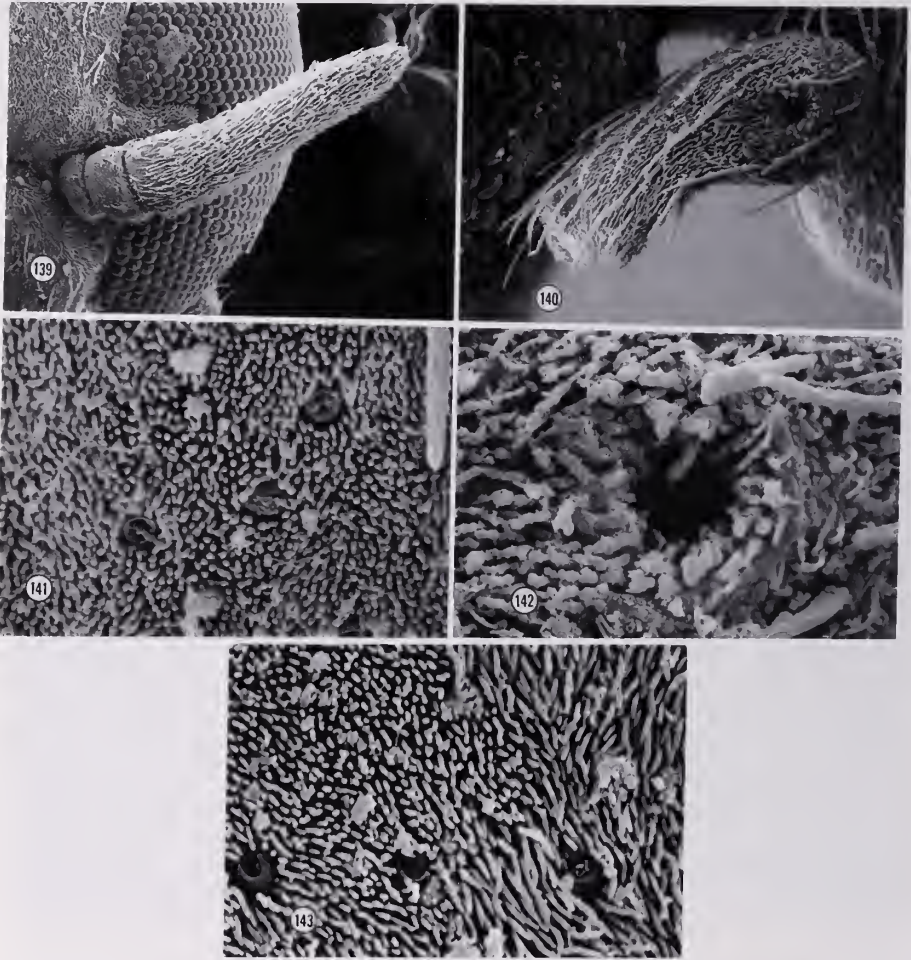


Figs. 126–132. SEM Micrographs. *Simulium mediovittatum*, female. 126. Portion of head showing antenna, and portion of third palpomere and eye. 127. Third palpomere showing mouth of sensory organ. 128. Claws and empodium. 129. Enlargement of mouth of sensory organ. 130. Portion of thorax showing variation in patterns of microtomentum. 131. More enlarged view of microtomentum. 132. More enlarged view of longer microtomentum.



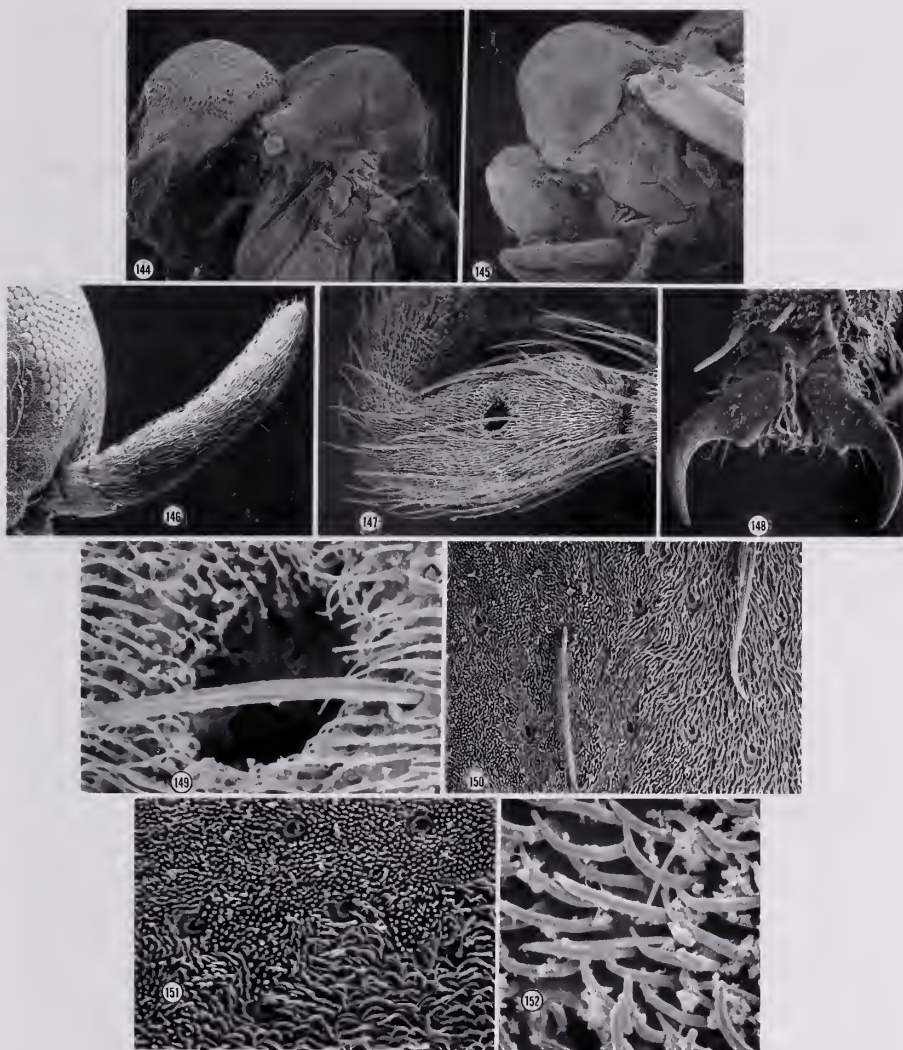
Figs. 133–138. SEM Micrographs. *Simulium trivittatum*. 133. Portion of female head showing antenna, third palpomere, frons, fronto-ocular triangle, and eye. 134. Enlarged view of mouth of sensory organ of female third palpomere. 135. Enlarged view of portion of thorax showing variation in microtomentum. 136. Female terminalia, posterior view. 137. Male terminalia, posterodorsal view. 138. Lateral view of male head.

REMARKS. *Simulium robynai* is variable in color but the orange form seems far more common than the darker form. Even so, the dark form usually has conspicuous amounts of orange color dorsally along the edges of the postpronotum, scutum and notopleuron. A number of the available specimens are dried and shriveled or are greased, and this may account for at least some of the darkening of the specimens. This species is similar to *labellei* especially in the shape of the scutum and terminalia of both sexes, and in the immature stages. These two species can be separated by the characters given in the keys. *Simulium robynai* seems to be a smaller, paler



Figs. 139–143. SEM Micrographs. *Simulium venator*, female. 139. Portion of head showing antenna, and parts of frons, fronto-ocular triangle, and eye. 140. Third palpomere showing mouth of sensory organ. 141. Enlarged view of portion of thorax showing microtomentum. 142. Enlarged view of mouth of sensory organ. 143. View of portion of thorax showing patterns of microtomentum.

version of *labellei* and the two species are obviously more closely related to each other than to the other species treated here, and may merit their own subgeneric placement. This species has been misidentified as *notatum*, but the two species are clearly distinct and are distinguished by the shape of the scutum, that of *notatum* being much more flattened than the conspicuously arched scutum of *robynae*. Other differences are found in the form of the female terminalia, and the darker legs in the female of *robynae*. Also, refer to the discussion under *labellei*.



Figs. 144–152. SEM Micrographs of *Simulium labellei*. 144. Lateral view of male head and thorax. 145. Lateral view of female head and thorax. 146. Portion of female head showing antenna, and parts of frons, fronto-ocular triangle, and eye. 147. Third palpomere of female showing mouth of sensory organ. 148. Female claws and empodium. 149. Enlarged view of mouth of sensory organ. 150. View of portion of thorax showing patterns of microtomentum. 151. More enlarged view of microtomentum of thorax. 152. More enlarged view of longer microtomentum of thorax.

Other workers thought that this species was *notatum*. According to Cockerell (1897), he was called on June 25, 1895, by Prof. A. Goss to see enormous numbers of specimens of this species on his horse, which was on the campus of the New Mexico Agricultural College, Mesilla Valley, New Mexico. According to Cockerell, Mr. D. W. Coquillett later identified this material as *Simulium ochraceum*, and suggested that since this species had never before, or since, been seen in the Mesilla Valley, that it must have arrived from some distance away. Although Coquillett apparently identified this material as *ochraceum*, he never mentioned its presence in New Mexico in his paper of 1898. However, he did mention *ochraceum* from Colorado and Montana but the specimens on which this identification was based were really *Prosimulium fulvum*, a species he named in 1902 (Malloch, 1914; Peterson, 1970). Malloch (1914) subsequently misidentified these three specimens as *notatum*, and Dyar and Shannon (1927) accepted this identification.

BIOLOGICAL NOTES. Practically nothing is known about the biology of this tiny species. Cockerell (1897) mentioned that it was taken from horses, and there are alcohol preserved specimens, with blood in their abdomens, labeled as from horses and a jackrabbit. Most of the material in the USNM was taken in light traps. Several pupae, two mature and several immature larvae were collected by the author from trailing vegetation along the margins of the Rio Grande, near Big Bend National Park, Texas, in the shallowest parts of the river. Both the pupae and larvae are pale yellowish in color and were difficult to see in the turbid waters of the river.

ACKNOWLEDGMENTS

I am grateful to P. (Nit) Malikul, laboratory technician, Systematic Entomology Laboratory, for her help in various ways, especially for taking and mounting most of the SEM micrographs. I am also grateful to Susann Braden, USNM, for her painstaking efforts in taking several of the very high magnification SEM micrographs. Most of the illustrations were commissioned under the initiative of Alan Stone, formerly of the Entomology Research Division, ARS, USDA, and were prepared by various artists with the former 406th Medical General Laboratory, U.S. Army, Japan. I am most grateful to Alan Stone for making these illustrations available for this paper. Some of the line illustrations were prepared by Linda H. Lawrence, staff illustrator, Systematic Entomology Laboratory (Figs. 51, 93, 110–121), and Elizabeth Lockett, contract illustrator, Baltimore, MD (Figs. 78–80, 90–92). I thank P. H. Adler, Department of Entomology, Clemson University, Clemson; K. P. Pruess, Department of Entomology, University of Nebraska, Lincoln; M. E. Craig, Department of Entomology, New Mexico State University, Las Cruces; R. E. White, A. L. Norrbom, M. E. Schauff, and D. R. Miller, Systematic Entomology Laboratory, who kindly read the manuscript and made helpful suggestions.

I am grateful to the following persons and institutions who loaned or contributed material for use in this study: P. H. Arnaud, Jr., California Academy of Sciences; R. C. Bechtel, Nevada State Department of Agriculture; G. W. Byers, and J. Gelhaus, University of Kansas (UKaL); M. E. Craig, New Mexico State University; J. M. Cumming, Agriculture Canada (CNC); W. J. Hanson, Utah State University; R. O. Hayes, Public Health Entomology, Consultation, Planning, Assessment, Domestic and Foreign, Fort Collins, Colorado; R. H. Jones, formerly Arthropod-borne Animal Diseases Research, ARS, USDA, Denver, Colorado; B. C. Kondratieff and M. Harris, Colorado State University; W. L. Kramer, Division of Environmental Health and Housing Surveillance, Nebraska Department of Health, Lincoln; K. P. Pruess, University of Nebraska.

LITERATURE CITED

- Abdelnur, O. M. 1968. The biology of some black flies (Diptera: Simuliidae) of Alberta. *Quaest. Entomol.* 4:113-174.
- Adams, C. F. 1904. Notes on and descriptions of North American Diptera. *Kansas Univ. Sci. Bull.* 2:433-455.
- Aldrich, J. M. 1905. A catalogue of North American Diptera (or two-winged flies). *Smithsonian Misc. Coll.* 46(1444):1-680.
- Anderson, J. R. and G. H. Voskuil. 1963. A reduction in milk production caused by the feeding of blackflies (Diptera: Simuliidae) on dairy cattle in California, with notes on the feeding activity on other animals. *Mosquito News* 23:126-131.
- Bacon, M. and R. H. McCauley, Jr. 1959. Black flies (Diptera: Simuliidae) in a newly developed irrigation district (Columbia Basin, Washington). *Northwest Sci.* 33:103-110.
- Barnard, D. R. 1979. A vehicle-mounted insect trap. *Can. Entomol.* 111:851-854.
- Braimah, S. A. 1987a. Mechanisms of filter feeding in immature *Simulium bivittatum* Malloch (Diptera: Simuliidae) and *Isonychia campestris* McDunnough (Ephemeroptera: Oligoneuriidae). *Can. Jour. Zool.* 65:504-513.
- Braimah, S. A. 1987b. Pattern of flow around filter-feeding structures of immature *Simulium bivittatum* Malloch (Diptera: Simuliidae) and *Isonychia campestris* McDunnough (Ephemeroptera: Oligoneuriidae). *Can. Jour. Zool.* 65:514-521.
- Braimah, S. A. 1987c. The influence of water velocity on particle capture by the labral fans of larvae of *Simulium bivittatum* Malloch (Diptera: Simuliidae). *Can. Jour. Zool.* 65:2395-2399.
- Burger, J. F. 1988. 10. Specialized habitat selection by black flies. Pages 129-145 in: K. C. Kim and R. W. Merritt (eds.), *Black Flies. Ecology, Population Management, and Annotated World List*. The Pennsylvania State University, University Park and London.
- Byers, G. W., F. Blank, W. J. Hanson, D. F. Beneway and R. W. Fredrickson. 1962. Catalogue of the types in the Snow Entomological Museum. Part III (Diptera). *Univ. Kansas Sci. Bull.* 43:131-181.
- Cameron, A. E. 1922. The morphology and biology of a Canadian cattle-infesting black fly, *Simulium simile* Mall. (Diptera, Simuliidae). *Can. Dept. Agr. Bull.* 5—New Series (Ent. Bull. 20), 26 pp.
- Chance, M. M. and D. A. Craig. 1986. Hydrodynamics and behaviour of Simuliidae larvae (Diptera). *Can. Jour. Zool.* 64:1295-1309.
- Cockerell, T. D. A. 1897. A buffalo gnat new to the United States. *Entomol. News* 8:100.
- Cole, F. R. 1969. The Flies of Western North America. *Univ. Calif. Press*, Berkeley and Los Angeles.
- Cole, F. R. and A. L. Lovett. 1921. An annotated list of the Diptera (flies) of Oregon. *Proc. Calif. Acad. Sci.*, 4th Ser. 11:197-344.
- Coquillett, D. W. 1898. The buffalo-gnats, or black-flies, of the United States. [A synopsis of the dipterous family Simuliidae.] *U.S. Dept. Agr., Div. Entomol., Bull.* 10—New Series: 66-69.
- Coquillett, D. W. 1902. New Diptera from North America. *Proc. U.S. Nat. Mus.* 25:83-126.
- Corkum, L. D. and D. C. Currie. 1987. Distributional patterns of immature Simuliidae (Diptera) in northwestern North America. *Freshwater Biology* 17:201-221.
- Coscarón, S. 1987. El género *Simulium* Latreille en la Región Neotropical: análisis de los grupos supraespecíficos, especies que los integran y distribución geográfica (Simuliidae, Diptera). *Museu Paraense Emílio Goeldi*, Belém, 112 pp.
- Crosskey, R. W. 1969. A re-classification of the Simuliidae (Diptera) of Africa and its islands. *Bull. Brit. Mus. (Nat. Hist.), Entomol. Suppl.* 14:1-195; 1 pl.

- Crosskey, R. W. 1988. Part VIII black fly species of the world. 32. An annotated checklist of the world black flies (Diptera: Simuliidae). Pages 425–520 in: K. C. Kim and R. W. Merritt (eds.), *Black Flies. Ecology, Population Management, and Annotated World List*. The Pennsylvania State University, University Park and London.
- Crosskey, R. W. 1990. *The Natural History of Blackflies*. John Wiley & Sons, Chichester, New York, Brisbane, Toronto, Singaore, ix + 711 pp.
- Crosskey, R. W. and C. A. Lowry. 1990. Simuliidae. Pages 201–235 in: B. C. Townsend (collator), *A Catalogue of the Types of Bloodsucking Flies in the British Museum (Natural History)*. Occasional Papers on Systematic Entomology 7.
- Currie, D. C. 1986. An annotated list of and keys to the immature black flies of Alberta (Diptera: Simuliidae). *Entomol. Soc. Can. Mem.* 134:1–90.
- Currie, D. C. and D. A. Craig. 1988. 12. Feeding strategies of larval black flies. Pages 155–170 in: K. C. Kim and R. W. Merritt (eds.), *Black Flies. Ecology, Population Management, and Annotated World List*. The Pennsylvania State University, University Park and London.
- Dalmat, H. T. 1954. Ecology of simuliid vectors of Onchocerciasis in Guatemala. *Amer. Midland Nat.* 52:175–196.
- Dalmat, H. T. 1955. The black flies (Diptera, Simuliidae) of Guatemala and their role as vectors of onchocerciasis. *Smithsonian Misc. Coll.* 125, viii + 425 pp., 44 pls.
- Dampf, A. 1927. Un simúlido nuevo de México (Orden Diptera, Sub-orden Nematocera), procedente de Tiltepec, Estado de Oaxaca. *Rev. Mex. Biol.* 7:125–130 (reprint paged 1–9) (listed as 1928).
- Depner, K. R. 1971. The distribution of black flies (Diptera: Simuliidae) of the mainstream of the Crowsnest-Oldman River system of southern Alberta. *Can. Entomol.* 103:1147–1151.
- Díaz Nájera, A. 1969. Simúlidos de Aguascalientes y Zacatecas. Descripción de seis especies del subgénero *Psilopelmia* y datos de dimorfismo. *Rev. Invest. Salud Pública* 29:21–63.
- Díaz Nájera, A. 1971. Descripción de una nueva especie del genero *Cnephia* del norte de Mexico. (Diptera: Simuliidae). *Rev. Invest. Salud Pública* 31:239–247.
- Díaz Nájera, A. and M. A. Vulcano. 1961. Descripción de *Simulium* (*Psilopelmia*) *longithallum* n. sp. (Diptera, Simuliidae). *Rev. Inst. Salbur. Enferm. trop.* 21:221–235.
- Drummond, R. O., J. E. George and S. E. Kunz. 1988. *Control of Arthropod Pests of Livestock: A Review of Technology*. CRC Press, Inc., Boca Raton, Florida.
- Duque, S., P. Muñoz de Hoyos and K. Rothfels. 1988. The polytene chromosomes of *Simulium* (*Ectemmaspis*) *ignescens* Roubaud and the related species *Simulium* “C,” both from Colombia. *Can. Jour. Zool.* 66:300–309.
- Dyar, H. G. and R. C. Shannon. 1927. The North American two-winged flies of the family Simuliidae. *Proc. U.S. Nat. Mus.* 69:1–54, Pls. 1–7.
- Edmunds, L. R. 1954. A note on irrigation drop structures as breeding sites of black flies in western Nebraska (Diptera: Simuliidae). *Mosquito News* 14:65–66.
- Emery, W. T. 1914. Morphology and biology of *Simulium vittatum* and its distribution in Kansas. *Kansas Univ. Sci. Bull.* 8:323–362, pls. 38–42.
- Enderlein, G. 1930. Der heutige Stand der Klassifikation der Simuliiden. *Arch. klassif. phylog. Entomol.* 1:77–97.
- Enderlein, G. 1934. Weiterer Ausbau des Systems der Simuliiden. (Dipt.). *Deutsche entomol. Zeitsch.* 1933:273–292.
- Essig, E. O. 1938. *Insects of Western North America*. Macmillan Co., New York.
- Fallis, A. M. 1964. Feeding and related behavior of female Simuliidae (Diptera). *Exp. Parasitol.* 15:439–470.
- Field, G. 1967. Studies on black flies of Panama (Diptera: Simuliidae). I. Two new species of *Simulium* of the subgenus *Notolepria*. *Ann. Entomol. Soc. Amer.* 60:188–194.
- Field, G. 1969. Studies of black flies of Panama (Diptera: Simuliidae). IV. A new species of *Simulium*. *Ann. Entomol. Soc. Amer.* 62:281–284.
- Fitch, H. S., F. Swenson and D. F. Tillotson. 1946. Behavior and food habits of the red-tailed hawk. *Condor* 48:205–237.

- Forattini, O. P., E. X. Rabello and M. D. Cotrim. 1971. Catálogo das coleções entomológicas da Faculdade de Saúde Pública da Universidade de São Paulo (1.a Série). Ceratopogonidae, Psychodidae, Simuliidae. Rev. Saúde Públ., S. Paulo 5:301-366.
- Francy, D. B., C. G. Moore, G. C. Smith, W. L. Jakob, S. A. Taylor and C. H. Calisher. 1988. Epizootic vesicular stomatitis in Colorado, 1982: Isolation of virus from insects collected along the northern Colorado Rocky Mountain Front Range. Jour. Med. Entomol. 25: 343-347.
- Fredeen, F. J. H. 1956. Research on black flies, pests of livestock and man on the Canadian prairies. Proc. Entomol. Soc. Man. 12:2-10.
- Fredeen, F. J. H. 1958. Black flies (Diptera: Simuliidae) of the agricultural areas of Manitoba, Saskatchewan, and Alberta. Proc. Tenth Internat. Congr. Entomol. 3:819-823.
- Fredeen, F. J. H. 1959. Rearing black flies in the laboratory (Diptera: Simuliidae). Can. Entomol. 91:73-83.
- Fredeen, F. J. H. 1964. On the determination of the approximate age of a black fly (Diptera: Simuliidae) and its significance. Can. Entomol. 96:109.
- Fredeen, F. J. H. 1973. Black flies. Agr. Can. Publ. 1499:1-19.
- Fredeen, F. J. H. 1977. A review of the economic importance of black flies (Simuliidae) in Canada. Quaest. Entomol. 13:219-229.
- Fredeen, F. J. H. 1981. Keys to the black flies (Simuliidae) of the Saskatchewan River in Saskatchewan. Quaest. Entomol. 17:189-210.
- Fredeen, F. J. H. 1985. The black flies (Diptera: Simuliidae) of Saskatchewan. Sask. Culture and Recreation Mus. Nat. Hist., Nat. Hist. Contr. 8:1-41, 31 maps.
- Fredeen, F. J. H. and J. A. Shemanchuk. 1960. Black flies (Diptera: Simuliidae) of irrigation systems in Saskatchewan and Alberta. Can. Jour. Zool. 38:723-735.
- Hall, F. 1974. A key to the *Simulium* larvae of southern California (Diptera: Simuliidae). Calif. Vector Views 21:65-71.
- Hannay, C. L. and E. F. Bond. 1971a. Blackfly wing surface. Can. Jour. Zool. 49:543-549.
- Hannay, C. L. and E. F. Bond. 1971b. Blackfly thoracic pollinosity. Can. Jour. Zool. 49:572-573; plate 1.
- Hearle, E. 1932. The blackflies of British Columbia (Simuliidae, Diptera). Proc. B.C. Entomol. Soc. 1932:5-19.
- Hidalgo Escalante, E. 1959. Simulidos del estado de Morelos (Dipt. Simuliidae). Acta Zool. Mex. 3:1-63, 3 pls., 12 maps.
- Iriarte, D. R. 1946. La familia Simuliidae en Venezuela. Capítulo II. Clasificación de los Simulidos. Bol. Lab. Clínica Luis Razetti 7:401-482.
- Jenkins, D. W. 1964. Pathogens, parasites and predators of medically important arthropods. Annotated list and bibliography. Suppl. Wld. Hlth. Org. 30:1-150.
- Johannsen, O. A. 1903. Part 6. Aquatic nematoceros Diptera. Pages 328-441, pls. 32-50 in: J. G. Needham, A. D. MacGillivray, O. A. Johannsen and K. C. Davis, Aquatic Insects of New York State. N.Y. State Mus. Bull. 68 [=Ent. 18]:197-517, 52 pls. (=N.Y. State Univ. Bull. 295.). (Also published in N.Y. State Mus. Ann. Rept. (1902) 57 (vol. 3, app. 6):328-441, 1904.)
- Jones, R. H. 1961. Some observations on biting flies attacking sheep. Mosquito News 21: 113-115.
- Jones, R. H. and D. H. Akey. 1977. Biting flies attacking holstein cattle in a bluetongue enzootic area in Colorado, 1976. Mosquito News 37:372-375.
- Jones, R. H., R. O. Hayes, H. W. Potter, Jr. and D. B. Francy. 1977. A survey of biting flies attacking equines in three states of the southwestern United States, 1972. Jour. Med. Entomol. 14:441-447.
- Knab, F. 1914. Simuliidae of Peru. Proc. Biol. Soc. Wash. 27:81-86.
- Knab, F. 1915a. New data and species in Simuliidae (Diptera). Insector Inscitiae Menstruus 2:177-180.
- Knab, F. 1915b. A new *Simulium* from Texas. Insector Inscitiae Menstruus 3:77-78.
- Knowlton, G. F. 1935. Simuliids annoy livestock. Jour. Econ. Entomol. 23:1073.

- Knowlton, G. F. and L. E. Fronk. 1950. Some blood sucking Diptera of Utah. Utah Agr. Exp. Sta. Mimeo. Ser. 369:1-9.
- Knowlton, G. F., F. C. Harmston and D. E. Hardy. 1938. Blood-sucking Utah Diptera. Utah Acad. Sci., Arts and Letters 15:103-105.
- Kramer, W. L., R. H. Jones, F. R. Holbrook, T. E. Walton and C. H. Calisher. 1990. Isolation of arboviruses from *Culicoides* midges (Diptera: Ceratopogonidae) in Colorado during an epizootic of Vesicular Stomatitis New Jersey. Jour. Med. Entomol. 27:487-493.
- Lacey, L. A. and M. S. Mulla. 1979. Field evaluation of diflubenzuron against *Simulium* larvae. Mosquito News 39:86-90.
- Lane, J. and M. A. Vulcano. 1943. A armadura bucal dos simuliídeos e seu valor taxonômico (Diptera, Simuliidae). Rev. Entomol. 14:430-440.
- Leon, J. R. de. 1963. Entomologia y transmision. Pages 125-182 in: Universidad de San Carlos de Guatemala, Enfermedad de Robles, Editorial Universitaria 43.
- Lindquist, A. W. and E. F. Knipling. 1957. Recent advances in veterinary entomology. Ann. Rev. Entomol. 2:181-202.
- Lowry, C. A. and A. J. Shelley. 1990. Studies on the scutal patterns of three South American *Simulium* species (Diptera: Simuliidae). Can. Jour. Zool. 68:956-961.
- Lutz, A. 1910. Segunda contribuição para o conhecimento das espécies brasileiras do genero "*Simulium*." Mem. Inst. Oswaldo Cruz 2:213-266 (in both Portuguese and German).
- MacNay, C. G., compiler. 1944. Insects affecting man and domestic animals. Can. Insect Pest Rev. 22(1):1-93.
- MacNay, C. G., compiler. 1952. Summary of important insect infestations, occurrences, and damage in Canada in 1952. Can. Insect Pest Rev. 30(10):297-341.
- MacNay, C. G., compiler. 1953. A regional review of insects of the season 1952. Can. Insect Pest Rev. 31(1):1-124.
- MacNay, C. G., compiler. 1954. Insects affecting man and domestic animals. Can. Insect Pest Rev. 32(2):156-159.
- MacNay, C. G., compiler. 1955. Insects affecting man and domestic animals. Can. Insect Pest Rev. 33(3):201-203.
- MacNay, C. G., compiler. 1956. Insects of potential economic importance new to certain regions or hosts in Canada, 1954: a review. Can. Insect. Pest Rev. 34(7):290-294.
- MacNay, C. G., compiler. 1958a. Insects attacking man & other animals. Can. Insect Pest Rev. 36(5):244-245.
- MacNay, C. G., compiler. 1958b. Insects attacking mammals and birds. Can. Insect Pest Rev. 36(6):272-273.
- MacNay, C. G., compiler. 1958c. Insects attacking mammals and birds. Can. Insect Pest Rev. 36(9):340-342.
- MacNay, C. G., compiler. 1959a. A regional review of insects of the season 1958. Can. Insect Pest Rev. 37(1):1-122.
- MacNay, C. G., compiler. 1959b. Insects affecting mammals and birds. Can. Insect Pest Rev. 37(2):138-140.
- MacNay, C. G., compiler. 1959c. Insects affecting man and other mammals. Can. Insect Pest Rev. 37(4):186-187.
- MacNay, C. G., compiler. 1959d. Summary of important insect infestations, occurrences, and damage in agricultural areas of Canada in 1959. Can. Insect Pest Rev. 37(9):265-297.
- MacNay, C. G., compiler. 1960a. A regional review of insects of the season 1959. Can. Insect Pest Rev. 38(1):1-111.
- MacNay, C. G., compiler. 1960b. Summary of important insect infestations, occurrences, and damage in agricultural areas of Canada in 1960. Can. Insect Pest Rev. 38(9):282-311.
- MacNay, C. G., compiler. 1961a. Summary of important insect infestations, occurrences, and damage in agricultural areas of Canada in 1961. Can. Insect Pest Rev. 39(9):269-296.

- MacNay, C. G., compiler. 1961b. A regional review of insects of the season 1961. Can. Insect Pest Rev. 39(10):297-392.
- MacNay, C. G., compiler. 1961c. Some new records in Canada, from the Canadian Insect Pest Record, 1955-1959, of arthropods of real or potential economic importance: a review. Can. Insect Pest Rev. 39 (Suppl. 1):1-38.
- MacNay, C. G., compiler. 1962. Summary of important insect infestations, occurrences, and damage in agricultural areas of Canada in 1962. Can. Insect Pest Rev. 40(8):159-185.
- Malloch, J. R. 1913. A new species of *Simulium* from Texas. Proc. Entomol. Soc. Wash. 15: 133-134.
- Malloch, J. R. 1914. American black flies or buffalo gnats. U.S. Dept. Agr. Bur. Entomol., Tech. Ser. 26:1-72, 6 pls.
- Newell, R. L. 1970. Checklist of some aquatic insects from Montana. Proc. Montana Acad. Sci. 30:45-56.
- Pan American Sanitary Bureau. 1950. Bibliography of Onchocercosis (Includes selected studies to June 1945). Pan Amer. Sanit. Bur. Publ. 242:1-339.
- Peters, R. H. and D. J. Womeldorf. 1966. *Simulium* annoying to humans in San Joaquin County, California, Calif. Vector Views 13:41.
- Peterson, B. V. 1955. A preliminary list of the black flies (Diptera: Simuliidae) of Utah. Proc. Utah Acad. Sci., Arts and Letters 32:113-115.
- Peterson, B. V. 1958. Simuliidae (family) Buffalo gnats, black flies. Pages 152-153 in: R. Anderson (ed.), Preliminary Report on Biological Resources of the Glen Canyon Reservoir. Univ. Utah Anthropological Papers 31.
- Peterson, B. V. 1959. Observations on mating, feeding, and oviposition of some Utah species of black flies (Diptera: Simuliidae). Can. Entomol. 91:147-155.
- Peterson, B. V. 1960a. Notes on some natural enemies of Utah black flies (Diptera: Simuliidae). Can. Entomol. 92:266-274.
- Peterson, B. V. 1960b. The Simuliidae (Diptera) of Utah, Part I. Keys, original citations, types and distribution. Great Basin Naturalist 20:81-104.
- Peterson, B. V. 1970. The *Prosimulium* of Canada and Alaska (Diptera: Simuliidae). Mem. Entomol. Soc. Can. 69:1-216.
- Peterson, B. V. 1981. Chapter 27, Simuliidae. Pages 355-391 in: J. F. McAlpine, B. V. Peterson, G. E. Shewell, H. J. Teskey, J. R. Vockeroth and D. M. Wood (coords.), Manual of Nearctic Diptera, Vol. 1. Res. Br., Agr. Can. Monogr. 27.
- Peterson, B. V. and K. R. Depner. 1972. A new species of *Prosimulium* from Alberta (Diptera: Simuliidae). Can. Entomol. 104:289-294.
- Peterson, D. G. and L. S. Wolfe. 1958. The biology and control of black flies (Diptera: Simuliidae) in Canada. Proc. Tenth Internat. Congr. Entomol. 3:551-564.
- Pinto, C. 1931. Simulidae da America Central e do Sul (Diptera). Sépt. Reun. Soc. Argentina Pat. Reg. Norte, Tucumán, 5-7 Octubre 1931:661-763 + Corrigenda.
- Pruess, K. P. 1989. Colonization of immature black flies (Diptera: Simuliidae) on artificial substrates in a Nebraska sandy river. Environ. Entomol. 18:433-437.
- Pruess, K. P. and B. V. Peterson. 1987. The black flies (Diptera: Simuliidae) of Nebraska: An annotated list. Jour. Kansas Entomol. Soc. 60:528-534.
- Reisen, W. K. 1974. The ecology of Honey Creek. A preliminary evaluation of the influence of *Simulium* spp. (Diptera: Simuliidae) larval populations on the concentration of total suspended particles. Entomol. News 85:275-278.
- Reisen, W. K. 1975a. The ecology of Honey Creek, Oklahoma: spatial and temporal distributions of the macroinvertebrates. Proc. Okla. Acad. Sci. 55:25-31.
- Reisen, W. K. 1975b. Quantitative aspects of *Simulium virgatum* Coq. and *S.* species life history in a southern Oklahoma stream. Ann. Entomol. Soc. Amer. 68:949-954.
- Reisen, W. K. 1977. The ecology of Honey Creek, Oklahoma: population dynamics and

- drifting behavior of three species of *Simulium* (Diptera: Simuliidae). Can. Jour. Zool. 55:325-337.
- Riley, C. V. 1887. Buffalo gnats. Order Diptera; family Simuliidae [Plates VI, VII, VIII, and IX]. Pages 492-517 in: Report of the Entomologist, Charles V. Riley, M.A., Ph.D., for the Year 1886. With Illustrations. Ann. Rept. Dept. Agr. 1886.
- Roubaud, E. 1909. Description d'une similie nouvelle du Pérou. Bull. Soc. Pathol. exot. 2:428-430.
- Rubtsov,* I. A. 1940. Fauna USSR. Insects Diptera. Family Simuliidae. [In Russian] Zool. Inst. Acad. Sci. USSR (N.S. 23) 6(6):1-533.
- Rubtsov, I. A. 1956. Fauna USSR. Insects Diptera. Black flies (Fam. Simuliidae). [In Russian] Zool. Inst. Acad. Sci. USSR (N.S. 64) 6(6):1-860 (also see the 1989 English translation edited by B. V. Peterson).
- Rubtsov, I. A. 1959-1964. Simuliidae (Melusinidae). Bd. 3 (4). Pages 1-689 in: E. Lindner (ed.), Die Fliegen der Palaearktischen Region. Schweizerbart, Stuttgart.
- Rubtsov, I. A. 1968. On the blackflies (Simuliidae) from Cuba. [In Russian] Parazitologiya 2:353-364.
- Rubtsov, I. A. 1974. Evolution, phylogeny and classification of the Family Simuliidae (Diptera). [In Russian] Trudy Zool. Inst. AH USSR 53:230-281.
- Rubtsov, I. A. and I. Garcia Avila. 1972. Los simulidos de Cuba (Diptera: Simuliidae). Poeyana Ser. 96:1-39.
- Ryckman, R. E. 1961. Parasitic Ceratopogonidae and Simuliidae (Diptera) from Imperial County, California. Jour. Parasitol. 47:405.
- Service, M. W. 1988. 14 Monitoring adult simuliid populations. Pages 187-200 in: K. C. Kim and R. W. Merritt (eds.), Black Flies. Ecology, Population Management, and Annotated World List. The Pennsylvania State University, University Park and London.
- Shemanchuk, J. A. and K. R. Depner. 1971. Seasonal distribution and abundance of females of *Simulium aureum* Fries (Simuliidae: Diptera) in irrigated areas of Alberta. Jour. Med. Entomol. 8:29-33.
- Shipp, J. L. 1985. Distribution of and notes on blackfly species (Diptera: Simuliidae) found in the major waterways of southern Alberta. Can. Jour. Zool. 63:1823-1828.
- Smart, J. 1944. Notes on Simuliidae (Diptera). II. Proc. R. Entomol. Soc. Lond. (B) 13:131-136.
- Smart, J. 1945. The classification of the Simuliidae (Diptera). Trans. R. Entomol. Soc. Lond. 95:463-528.
- Smith, J. P. and W. F. Rapp. 1987. Black flies (Diptera: Simuliidae) in Nebraska. N.J. Mosq. Cont. Assoc. Proc. 72nd Ann. Mtg.: 135-136.
- Snyder, T. P. and D. G. Huggins. 1980. Kansas black flies (Diptera: Simuliidae) with notes on distribution and ecology. Tech. Publ. State Biol. Surv. Kansas 9:30-34.
- Stains, G. S. and G. F. Knowlton. 1943. A taxonomic and distributional study of Simuliidae of western United States. Ann. Entomol. Soc. Amer. 36:259-280.
- Stone, A. 1963. An annotated list of genus-group names in the family Simuliidae (Diptera). U.S. Dept. Agr. Tech. Bull. 1284:1-28.
- Stone, A. 1965. Family Simuliidae. Pages 181-189 in: A. Stone, C. W. Sabrosky, W. W. Wirth, R. H. Foote and J. R. Coulson (eds.), A Catalog of the Diptera of America North of Mexico. U.S. Dept. Agr., Agr. Handb. 276.
- Strickland, E. H. 1946. An annotated list of the Diptera (flies) of Alberta. Additions and corrections. Can. Jour. Res., D., 24:157-173.

* Also spelled: Rubtzov, Rubzov, Rubsov, Rubcov, plus several other versions. Rubtsov is adopted here to maintain consistency with recent common usage by English speaking black fly workers.

- Tipton, V. J. and R. C. Saunders. 1971. A list of arthropods of medical importance which occur in Utah with a review of arthropod-borne diseases endemic in the state. Brigham Young Univ. Sci. Bull., Biol. Ser., 15:1-31.
- Travis, B. V. and R. M. Labadan. 1967. Arthropods of medical importance in Latin America. Part II. U.S. Army Natick Lab., Tech. Rept. 68-30-ES-35: x + 217-244, 1 map.
- Travis, B. V., H. H. Lee and R. M. Labadan. 1969. Arthropods of medical importance in America north of Mexico. U.S. Army Natick Lab., Tech. Rept. 69-2-ES: xii + 111-143, 1 map.
- Travis, B. V., M. Vargas V. and J. C. Swartzwelder. 1974. Bionomics of black flies (Diptera: Simuliidae) in Costa Rica. I. Species biting man, with an epidemiological summary for the Western Hemisphere. Rev. Biol. Trop. 22:187-200.
- Twinn, C. R. 1938. Blackflies from Utah and Idaho, with descriptions of new species (Simuliidae, Diptera). Can. Entomol. 70:48-55.
- Vargas, L. 1941. *Simulium lane-portoi* n.n. (Simuliidae, Dipt.) y lista de simúlidos mexicanos. Rev. Inst. Salubr. Enferm. trop. 2:115-122.
- Vargas, L. 1942. Notas sobre la terminalia de algunos simúlidos de Mexico. *S. (E.) paynei* n.n. Vargas, 1942. Rev. Inst. Salubr. Enferm. trop. 3:229-257.
- Vargas, L. 1943. Nuevos datos sobre simúlidos mexicanos (Dipt. Simuliidae). Rev. Inst. Salubr. Enferm. trop. 4:359-370.
- Vargas, L. 1945a. Notas sobre la oncocerciasis. II. El factor luz y los simúlidos adultos. Rev. Inst. Salubr. Enferm. trop. 6:61-66.
- Vargas, L. 1945b. Cuatro nuevas especies y otros datos sobre simúlidos de Mexico. Rev. Soc. Mex. Hist. Natural 6:71-83, pls. 7-12.
- Vargas, L. 1945c. Simúlidos del Nuevo Mundo. Inst. Salubr. Enferm. Trop. Monogr. Num. 1, viii + 241 pp.
- Vargas, L. and A. Díaz Nájera. 1948a. Nota sobre la identificación de los simúlidos de Mexico. El subgenero *Mallochianella* n.n. Rev. Inst. Salubr. Enferm. trop. 9:65-74.
- Vargas, L. and A. Díaz Nájera. 1948b. Nuevas especies de simúlidos de Mexico y consideraciones diversas sobre especies ya descritas. Rev. Inst. Salubr. Enferm. trop. 9:321-369.
- Vargas, L. and A. Díaz Nájera. 1949. Claves para identificar las pupas de los simúlidos de Mexico. Descripción de *Simulium (Dyarella) freemani* n. sp. de *Simulium (Neosimulium) enciso* n. sp. y referencias adicionales sobre *S. anduzei* y *S. ruizi*. Rev. Inst. Salubr. Enferm. trop. 10:283-319.
- Vargas, L. and A. Díaz Nájera. 1951a. Notas sobre sistematica y morfología de simúlidos. Rev. Soc. Mex. Hist. Nat. 12:123-207.
- Vargas, L. and A. Díaz Nájera. 1951b. Nota sobre los simúlidos de Mexico y su distribución geográfica (Diptera: Simuliidae). Rev. Inst. Salubr. Enferm. trop. 12:89-100.
- Vargas, L. and A. Díaz Nájera. 1953a. Nota sobre el examen de tipos de simúlidos descritos por el Prof. G. Enderlein. Rev. Inst. Salubr. Enferm. trop. 13:137-149, 3 pls.
- Vargas, L. and A. Díaz Nájera. 1953b. Nota sobre Simúlidos del Ecuador I. Descripción del macho de *Simulium (Psilopelmia) escomeli* Roubaud, 1909. (Diptera: Simuliidae). Rev. Ecuat. Entomol. Par. 1:17-23.
- Vargas, L. and A. Díaz Nájera. 1954. Algunas consideraciones morfológicas y de nomenclatura relativas a simúlidos americanos. (Diptera: Simuliidae). Rev. Inst. Salubr. Enferm. trop. 14:57-72, 8 pls.
- Vargas, L. and A. Díaz Nájera. 1957. Simúlidos mexicanos. Rev. Inst. Salubr. Enferm. trop. 17:143-399.
- Vargas, L. and A. Díaz Nájera. 1958. Nota sobre *Simulium (Psilopelmia) bivittatum* Malloch, 1914 (Diptera: Simuliidae). Rev. Inst. Salubr. Enferm. trop. 18:13-30.
- Vargas, L. and A. Díaz Nájera. 1959. Claves gráficas para identificar generos y subgeneros de larvas, pupas y adultos de simúlidos (Diptera: Simuliidae). Rev. Inst. Salubr. Enferm. trop. 19:105-114.

- Vargas, L., A. Díaz Nájera and A. Martínez Palacios. 1943. Tres simulidos nuevos para Mexico. *Rev. Inst. Salubr. Enferm. trop.* 4:287-290, 2 pls.
- Vargas, L., A. Martínez Palacios and A. Díaz Nájera. 1946. Simulidos de Mexico. Datos sobre sistemática y morfología, descripción de nuevos subgéneros y especies. *Rev. Inst. Salubr. Enferm. trop.* 7:101-192, 25 pls.
- Vulcano, M. A. 1967. 16 Family Simuliidae. Pages 16.1-16.44 in: N. Papavero (ed.), *A Catalogue of the Diptera of the Americas South of the United States*. Dept. Zool., Sect. Agr., São Paulo.
- Wirth, W. W. and A. Stone. 1956. Aquatic Diptera. Pages 372-482 in: R. L. Usinger (ed.), *Aquatic Insects of California, with Keys to North American Genera and California Species*. University of California Press, Berkeley and Los Angeles.
- Wiseman, J. S. and R. B. Eads. 1960. Texas blackfly records (Diptera: Simuliidae). *Mosquito News* 20:45-49.
- Wygodzinsky, P. 1950. Contribuciones al conocimiento de los Simuliidae Argentinos. 111. *Simulium dinellii* (Joan, 1912) y *Simulium wolffhügeli* (Enderlein, 1922). *An. Inst. Med. Reg.* 3:75-97.
- Wygodzinsky, P. 1953. Sobre algunos simulidos Argentinos (Diptera). *An. Inst. Med. Reg.* 3:293-320.

Received 17 April 1992; accepted 6 August 1992.

TWO NEW GENERA FOR NEW WORLD VELIINAE (HETEROPTERA: VELIIDAE)

JOHN T. POLHEMUS¹ AND DAN A. POLHEMUS²

¹University of Colorado Museum, 3115 S. York St.,
Englewood, Colorado 80110, and

²Department of Entomology, Bishop Museum, P.O. Box 19000-A,
Honolulu, Hawaii 96817-0916

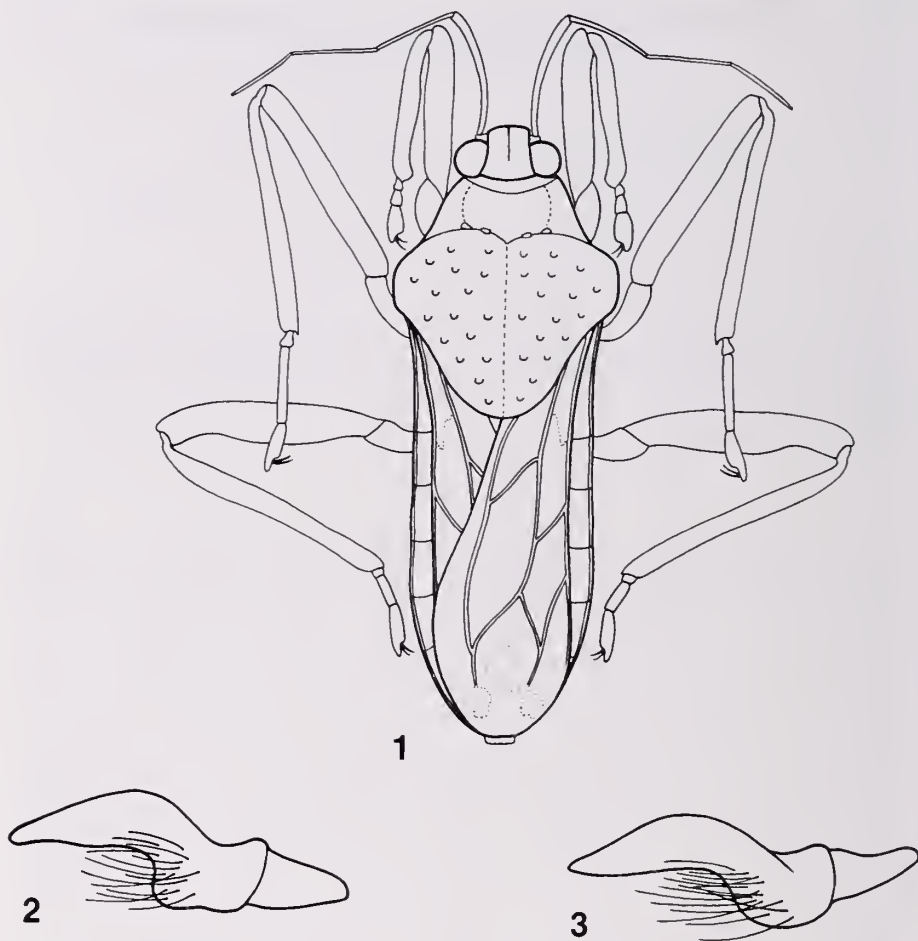
Abstract.—Two new taxa are proposed for veliids presently placed in the genus *Paravelia*; *Platyvelia* new genus, type-species *Velia brachialis* Stål, and *Steinovelie* new genus, type-species *Velia stagnalis* Burmeister. The synonymy of *Platyvelia brachialis* (Stål) 1860 and *Platyvelia australis* (Torre-Bueno) 1916 is discussed and confirmed. A checklist of included species is given for each new genus.

The subfamily Veliinae in the Western Hemisphere presently contains four genera: *Veloidea* Gould, *Stridulivelia* Hungerford (with 2 subgenera, *Stridulivelia* sensu stricto and *Aenictovelie* J. Polhemus), *Oiovelia* Drake, and *Paravelia* Breddin. Species of the last genus were included in the Old World genus *Velia* until J. Polhemus (1976) showed that they were distinct. With the notable exception of *Paravelia*, all of the foregoing New World genera are monophyletic. *Paravelia*, on the other hand, contains at least five recognizable groups that we believe warrant separate generic status; all of these are separable from each other by the structure of the thoracic sternum, or by the distinctive morphology of the abdominal terminalia in both males and females. Two of these groups are proposed as new genera herein, in advance of our anticipated larger work on the *Paravelia* complex as a whole, in order to stabilize the nomenclature for North America and to provide names for several ongoing studies, e.g., zoogeographical studies in our laboratories, and life history studies at Southern Illinois University, Carbondale. These two new genera, *Platyvelia* and *Steinovelie*, are easily separated from *Paravelia* Breddin by the markedly different morphology of the thoracic sternum (Figs. 5, 7). Both of these new genera contain undescribed species, and future revisions will be necessary for each of them.

***Platyvelia*, new genus**

Figs. 1-3, 5

Description: Ground color brown, marked with silvery pubescence. Robust (Fig. 1), length 4.0 to 6.5 mm, general body characteristics and size not sexually dimorphic. Eyes globose, exserted, separated by more than an eye width, appressed to anterior pronotal margin, without visible ocular setae. Head declivant anteriorly, recessed into pronotum, with usual three pairs of facial trichobothria; gular region short, often not visible. Rostrum with segment I extending far past bucculae, I and IV subequal in length and slightly longer than II, segment III about 4 times as long as II. Pronotum of apterous form raised medially; collar broad, prominent, set off by prominent foveae, sometimes laterally expanded into knobs posterior to eyes; anterior and



Figs. 1-3. *Platytelia brachialis* (Stål). 1. Dorsal habitus, macropterous male from Nueces River, Zavala Co., Texas. 2. Male paramere, individual from Nueces River, Zavala Co., Texas. 3. Male paramere, individual compared with holotype, from Nova Teutonia, Santa Catarina, Brazil.

posterior lobes set off by a transverse row of 4 large deep foveae; triangular lateral region of anterior lobe depressed, set with silvery setae; posterior lobe with numerous deep foveae, humeri not prominent, broadly rounded posteriorly, not modified, covering metanotum in some species. Pronotum of alate form longer, posterior margin extending farther caudad, humeri more prominent. Thoracic venter diagnostic, mesoacetabulae sculptured medially, posterior margin forming a large tubercle opposing an anteriorly directed tubercle on each side of metasternum (Fig. 5). Metasternal scent gland opening (omphalium) usually marked by a raised median protuberance on the posterior part.

Abdomen usually with small areas of silvery setae dorsally on connexiva at the

suture between segments; apterous and micropterous forms usually with silvery setae medially on tergite V, and laterally on tergites VI and VII; prominent paired longitudinal carinae on tergites II–IV and basally on tergite V of macropters (visible only after removal of wings), weakly indicated or absent in apterous form. Abdominal sternites set off from laterosternites by hair-free longitudinal striae or elongate lacunae, usually also by silvery setae; male sternite VII may possess a median process posteriorly. Micropters with elongate white wing pads; macropters with four closed cells in dark hemelytra with white spots in characteristic pattern (Fig. 1).

Legs stout; anterior femur often thickly set beneath with short dark setae; anterior tibia with a distal transverse comb of many stiff setae; middle, hind and sometimes anterior femora often set ventrally with numerous black denticles; middle tarsi long, claws very long and slender, when folded back reaching base of third tarsal segment.

Male genital segments large; proctiger unmodified; parameres symmetrical, broad, sculptured or elongate. Female tergite VIII on same plane as VII, truncate posteriorly; first gonocoxae large, exposed, plate-like; tergite IX small, button-like, protruding posteriorly.

Type species. *Velia brachialis* Stål, 1860.

Distribution. United States (mid Atlantic states, southeast, southwest) southward to Brazil.

Etymology. The generic name *Platyvelia* is derived from *platys* (Gr.), broad, referring to the robust body shape, and *Velia*, the nominate genus of the family. Gender feminine.

Discussion. This genus is easily separated from *Paravelia* and all other Veliinae by the position of the opposing tubercles on the meso- and metasternum (Fig. 5); in *Paravelia* the opposing tubercles are located either side of the midline and much closer together. The pattern of white spots on the hemelytra (Fig. 1) and corresponding markings composed of silvery setae in apterous specimens also constitute an apomorphy for the genus. The lack of ocular setae in both nymphs and adults of this genus is a characteristic shared with *Steinovelia* new genus (Fig. 6), several species comprising another New World group presently held in *Paravelia*, and the Old World genus *Ocellovelia*. This character is apparently a secondary loss, since such ocular setae occur in all other Veliidae checked, including many species in almost all of the presently described genera. Andersen (1982, p. 142) noted the lack of ocular setae in the Ocelloveliinae, the most plesiomorphic subfamily in his cladogram of Veliidae (p. 180), and stated that their absence is rare, but did not specifically state that they are present in all members of other subfamilies. With the presently noted exceptions, they seem to be uniformly present. Their absence in certain Veliinae, the most apomorphic member of Andersen's veliid subfamilial cladogram, strongly suggests that the loss has occurred independently in several veliid lineages.

Platyvelia brachialis (Stål), New Combination

Figs. 1–3, 5

Velia brachialis Stål, 1860:82. Holotype, macropterous male, Rio de Janeiro, Brazil; Natural History Museum, Stockholm.

Velia australis Torre Bueno, 1916:54. Holotype, macropterous male, Florida, Torre Bueno Collection, now at the University of Kansas, Lawrence (?). Synonymized with *Velia brachialis* Stål 1860 by Blatchley, 1926:1002.

Paravelia brachialis Polhemus, 1976:512. New combination.

Discussion. We have studied the type of *Velia brachialis* Stål as well as additional material from Brazil (Goiás, Santa Catarina), Peru, Surinam, Costa Rica, Nicaragua, Mexico and numerous localities in the southeastern United States. The parameres of examples from Texas and Brazil are shown in Figures 2 and 3. Although there are slight differences in parameres from different populations, we cannot consistently separate the populations from North and South America even after a careful analysis of many somatic characters, thus the synonymy above is considered valid for the present. The somatic characters that are useful in separating species of this genus include the armature on the legs and abdominal terminalia, length of setae on the legs, morphology of male sternite 7, details of body shape (especially the pronotum), banding of the legs, and antennal ratio. It may ultimately be shown that *P. egregia* Drake and Harris is also a synonym of *P. brachialis*.

Checklist of *Platyvelia* species

(All of the following are removed from the genus *Paravelia*)

<i>alvaradana</i> (Drake & Hottes) 1952. [<i>Velia</i>] New combination	Mexico
<i>annulipes</i> (Champion) 1898. [<i>Velia</i>] New combination	Guatemala
<i>beameri</i> (Hungerford) 1929. [<i>Velia</i>] New combination	Southwest United States
<i>brachialis</i> (Stål) 1860. [<i>Velia</i>] New combination	Southeast United States;
syn. <i>australis</i> (Torre Bueno) 1916. [<i>Velia</i>] New combination	Brazil; Peru
<i>egregia</i> (Drake & Harris) 1935. [<i>Velia</i>] New combination	Panama; South America
<i>maritima</i> (Polhemus & Manzano) 1992. [<i>Paravelia</i>] New combination	Colombia
<i>summersi</i> (Drake) 1951. [<i>Velia</i>] New combination	Southwest United States
<i>verana</i> (Drake & Hottes) 1952. [<i>Velia</i>] New combination	Mexico
<i>verdica</i> (Drake) 1951. [<i>Velia</i>] New combination	Brazil

Steinovelia, new genus

Figs. 4, 6–8

Description: Ground color brown. Body form slender (Fig. 4), length 4.2 to 5.5 mm, general body characteristics and size not sexually dimorphic. Eyes globose, exserted, separated by more than an eye width, not appressed to anterior pronotal margin, without visible ocular setae (Fig. 6). Head porrect to moderately declivant anteriorly, not recessed into pronotum, with usual three pairs of facial trichobothria; gular region long, depressed longitudinally forming a shallow sulcus. Rostrum with segment I extending far past bucculae, I and IV subequal in length and slightly longer than II, III about 4 times as long as II. Pronotum of apterous form raised medially; collar not raised, set off by prominent foveae; anterior and posterior lobes set off by a transverse row of large deep foveae; small lateral region of anterior lobe just anterad of this demarcating row of pits often set with silvery setae; posterior lobe with numerous deep foveae, humeri prominent and sometimes spine-like, posterior mar-

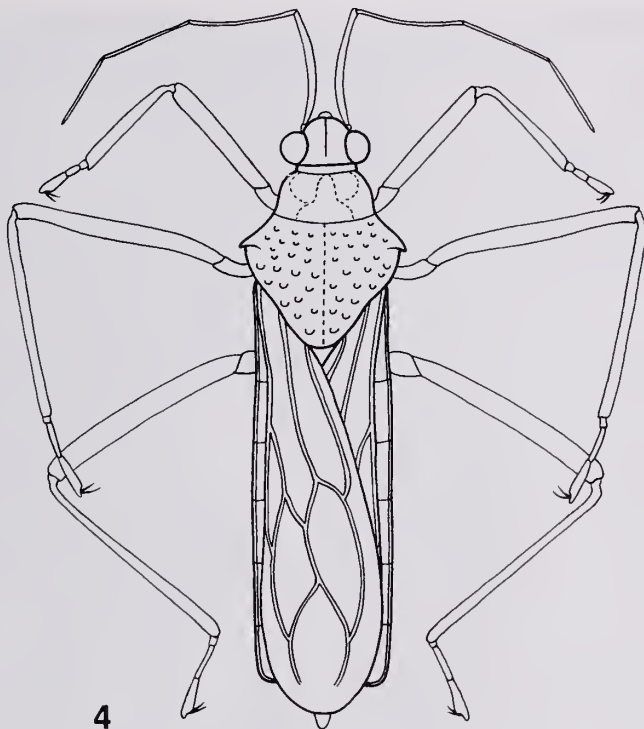


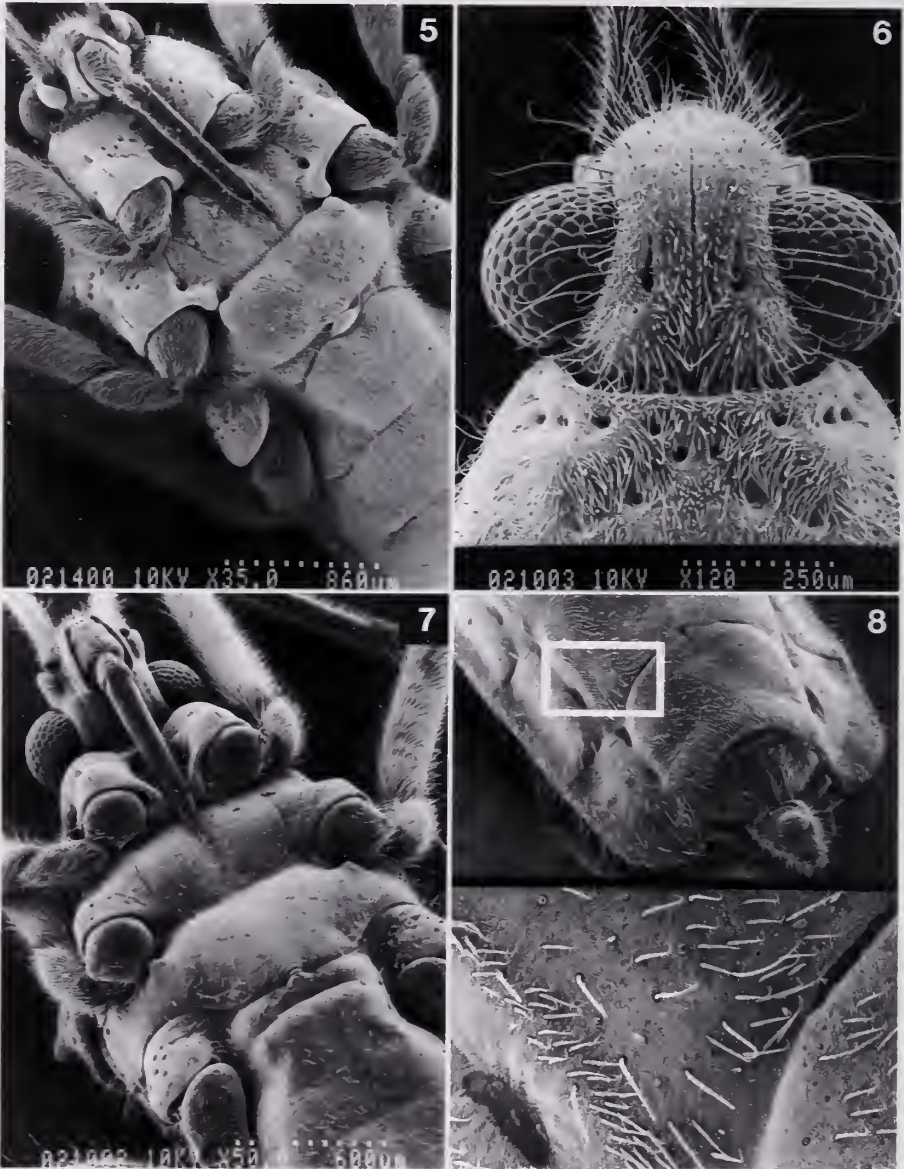
Fig. 4. *Steinovelia virgata* (White). Dorsal habitus, macropterous female from Nova Teutonia, Santa Catarina, Brazil.

gin broadly rounded posteriorly, not modified, usually covering metanotum. Pronotum of alate form similar to apterous form, but humeri more prominent. Thoracic venter diagnostic, with meso-coxae opposing a pair (1+1) of anteriorly directed tubercles on each side of metasternum (Fig. 7). Metasternal scent gland opening (omphalium) usually marked by a small raised median protuberance on the posterior part.

Abdomen dorsally without silvery setae; prominent paired longitudinal carinae on tergites II and III of macropterous and apterous forms. Abdominal sternites set off from laterosternites by narrow hair-free striae (Fig. 8); male sternite VII not modified. Micropters with small narrow elongate brown wing pads; macropters with four closed cells in light colored hemelytra with prominent veins and brownish markings without characteristic pattern (Fig. 4).

Legs slender; anterior femur often thickly set beneath with short dark setae; anterior tibia with a distal transverse comb of many stiff setae; middle and hind femora often set ventrally with numerous black denticles; middle and hind tarsi similar, claws similar, of moderate length, slender.

Male genital segments large, elongate; proctiger unmodified; parameres symmetrical, usually narrow, elongate. Female tergite VIII on same plane as VII, broadly



Figs. 5–8. Scanning electron micrographs showing structural details of *Platytelia* and *Steinovelvia* species. 5. *Platytelia brachialis* (Stål). Ventral view of head, thorax, and basal abdomen. Note opposing metasternal and mesoacetabular tubercles. Magnification 35 \times . 6. *Steinovelvia virgata* (White). Dorsal view of head. Note absence of ocular setae. Magnification 120 \times . 7. *Steinovelvia virgata* (White). Ventral view of head, thorax and basal abdomen. Note metasternal tubercles opposed to meso-coxae. Magnification 50 \times . 8. *Steinovelvia virgata* (White). Ventral view of distal abdomen. Note shape and location of hair free depressions between sternites and laterosternites. Magnification 50 \times for upper image, 250 \times on inset.

rounded posteriorly; first gonocoxae large, exposed, plate-like; tergite IX protruding posteriorly, tapering, triangular, elongate.

Type species. *Velia stagnalis* Burmeister, 1835.

Distribution. United States (mid Atlantic states, southeast), Caribbean (Cuba, Hispaniola, Trinidad), South America (widespread from the north coast southward to Paraguay and Brazil).

Etymology. The generic name *Steinovelia* is derived from *Steinos*, a variant spelling of *Stenos* (Gr.), narrow, referring to the slender body shape, and *Velia*, the nominate genus of the family. Gender feminine. The name *Steinovelia* was used by Scudder (1890) for a Tertiary fossil water strider from the Florissant beds.

Discussion. This genus is easily separated from *Paravelia* and all other Veliinae by the position of the metasternal tubercles opposing the meso-coxae (Fig. 7). The long narrow body shape is also a characteristic of this genus. The lack of ocular setae in both nymphs and adults of this genus is a characteristic shared with only a few other Veliidae; see discussion under *Platyvelia*.

Checklist of *Steinovelia*, new genus
(All of the following are removed from the genus *Paravelia*)

<i>permista</i> (Drake) 1951. [<i>Velia</i>] New combination	Haiti; Puerto Rico; Trinidad
<i>placida</i> (Drake) 1951. [<i>Velia</i>] New combination	Trinidad
<i>stagnalis</i> (Burmeister) 1835. [<i>Velia</i>] New combination	Southeast United States;
syn. <i>paulianae</i> (Wilson) 1953. [<i>Velia</i>] New combination	Cuba
syn. <i>watsoni</i> (Drake) 1919. [<i>Velia</i>] New combination	
<i>vinnula</i> (Drake) 1951. [<i>Velia</i>] New combination	Brazil
<i>virgata</i> (Buchanan White) 1879. [<i>Velia</i>] New combination	Brazil

ACKNOWLEDGMENTS

We are indebted to the following for the exchange, gift or loan of material: Dr. R. Brooks, University of Kansas, Lawrence (SEMC); Dr. Per Lindskog, Natural History Museum, Stockholm; Dr. R. T. Schuh, American Museum of Natural History, New York (AMNH); Dr. H. H. Weber, Kiel; Dr. P. J. Spangler, Dr. R. C. Froeschner and the late Dr. C. J. Drake, Smithsonian Institution, Washington, D.C. (USNM); Dr. J. Maldonado Capriles, Cayey, Puerto Rico; Dr. N. Nieser, Tiel, The Netherlands. Our special thanks to Tina Carvalho and Marilyn Dunlap of the Biological EM Facility, University of Hawaii at Manoa, for assistance with the scanning electron micrographs, and to J. McPherson for first calling our attention to the lack of ocular setae in the new genera proposed herein.

LITERATURE CITED

- Andersen, N. M. 1982. The Semiaquatic Bugs (Hemiptera, Gerromorpha). Phylogeny, Adaptations, Biogeography and Classification. Scandinavian Science Press, Klampenborg, Denmark, Entomonograph Vol. 3, 455 pp.
- Blatchley, W. S. 1926. Heteroptera or True Bugs of Eastern North America. Nature Publ. Co., Indianapolis, 1,116 pp.
- Polhemus, J. T. 1976. A reconsideration of the status of the genus *Paravelia* Breddin, with

- other notes and a check list of species (Veliidae: Heteroptera). J. Kansas Ent. Soc. 49: 509-513.
- Scudder, S. H. 1890. The Tertiary Insects of North America. Rept. U.S. Geol. Surv. Terr., F. V. Hayden Reports 13:1-734.
- Stål, C. 1860-1862. Bidrag till Rio Janeiro-Traktens Hemipter-Fauna. Svenska Vet.-Ak. Handl. 2(7):1-84 (1860); 3(6):1-75 (1862).
- Torre Bueno, J. R. de la. 1916. The Veliinae of the Atlantic states. Bull. Brooklyn Ent. Soc. 11:52-61.

Received 30 March 1992; accepted 17 September 1992.

THE GENUS *DORCADOTHRIPS*
(THYSANOPTERA: THIRIPIDAE) IN HAWAII AND
NORTH AMERICA WITH A DESCRIPTION OF
A NEW SPECIES

SUEO NAKAHARA

Systematic Entomology Laboratory, PSI, Agricultural Research Service, USDA,
10300 Baltimore Ave., Beltsville, Maryland 20705-2350

Abstract.—The genus *Dorcadothrips* is reviewed for Hawaii and North America. *Dorcadothrips oahuensis*, new species, on sweet basil in Hawaii is described and the males of *D. cyperaceae* (Bianchi) and *D. xanthius* (Williams) are described for the first time. A key to identify the females and males of these three species and *D. walteri* (Crawford) is provided.

The genus *Dorcadothrips* currently consists of 18 species. The type species, *D. caespitis* Priesner, was described from Egypt and Sudan, five species were described from India, six species from Indonesia, and one species each from the Philippines, New Guinea and Australia. Three species were described from Hawaii and the Western Hemisphere: *D. cyperaceae* (Bianchi) from Hawaii, *D. walteri* (Crawford) from Michigan and *D. xanthius* (Williams) from Trinidad. *Dorcadothrips* was first used in North America by Hood (1941:145) for *nevini* Hood from New York state. Stannard (1968:306) treated the species as a junior synonym of *Taeniothrips walteri* Crawford and transferred *walteri* to *Dorcadothrips*. A new species, *D. oahuensis*, found in a field of sweet basil, *Oncimum basilicum* L., on the island of Oahu in Hawaii, is here described. In my opinion the four species from Hawaii and the Western Hemisphere are adventive from India or southeast Asia (e.g., *D. walteri* occurs in at least five provinces in India according to Bhatti (1990:227)).

The males of only six of the 18 species are known (Bhatti 1978a:168, 1978b:419). The males of *D. cyperaceae*, *D. oahuensis* and *D. xanthius* are here described for the first time and that of *D. walteri* is redescribed. A generic redescription and descriptions and a key to the four species are presented.

Measurements of all morphological characters are in microns except for the body length which is given in millimeters. Measurements of the holotype are given first followed by those of the paratypes in parentheses except for the antennal segments. USNM is used as an acronym for the United States National Museum of Natural History, Washington D.C.

Genus *Dorcadothrips*

Type species: *Dorcadothrips caespitis* Priesner, 1932:49 by original designation and monotypy.

Female macropterous. Body generally pale yellow. Antenna 8-segmented, rather elongate, segments III–IV with trichomes. Head with 2 pairs of ocellar setae, pair 1 absent; eye without pigmented ventral facets; maxillary palp 3-segmented. Pronotal posteroangular setae well developed, 2 pairs; posteromarginal setae 2 pairs; medial

setae on metanotum posterior of anterior margin; spinula on mesothoracic furca normally developed, absent from metathoracic furca. Forewing with 2 distal setae on forevein, scale with 4–5 marginal and 1 discal setae; posterior fringe cilia wavy. Abdominal tergites lacking ctenidia; posteromarginal comb absent from tergite VIII, sensilla absent from tergite IX, tergite X without dorsal slit. Abdominal sternite II with 2 pairs of major setae, 3 pairs on posterior margin of sternites III–VII, accessory setae present or absent from sternites.

Male apterous or macropterous. A pair of stout processes on abdominal tergite IX. Abdominal sternites III–VII each with an elongate and/or several oval glandular areas.

KEY TO HAWAIIAN AND NORTH AMERICAN SPECIES

- 1 Abdominal sternites with accessory setae (Fig. 13) 2
- Abdominal sternites without accessory setae 3
- 2(1) Vertex of head with 3 small, anteromedial tubercles (Fig. 1); trichomes on antennal segments III–IV not distinctly yoked at base (Fig. 3); forewing and sides of mesothorax pale yellow; abdominal sternites III–VII of male each with 5 glandular areas *cyperaceae* (Bianchi)
- Vertex of head without small tubercles; trichomes on antennal segment III–IV often distinctly yoked at bases; forewing shaded pale brown basally with a short, pale brown band on proximal $\frac{1}{3}$, sides and spiracular area of mesothorax brown; abdominal sternites III–VII of male each with 3 glandular areas (Fig. 13) *walteri* (Crawford)
- 3(1) Head brown between eyes, pale posterior of eyes; abdominal sternites V–VI of female with submarginal brown area with rough callosity on each side (Fig. 7); male with 5 glandular areas on sternites II–VII, medial gland transversely elongate *xanthius* (Williams)
- Head pale yellow between eyes, brown posterior of eyes (Fig. 2); abdominal sternites V–VI of female pale yellow, without callosities; male with 6 glandular areas on sternites III–VII, 2 oval medial glands present (Fig. 12) *oahuensis* Nakahara n. sp.

Dorcadothrips cyperaceae (Bianchi)

Figs. 1, 3, 8

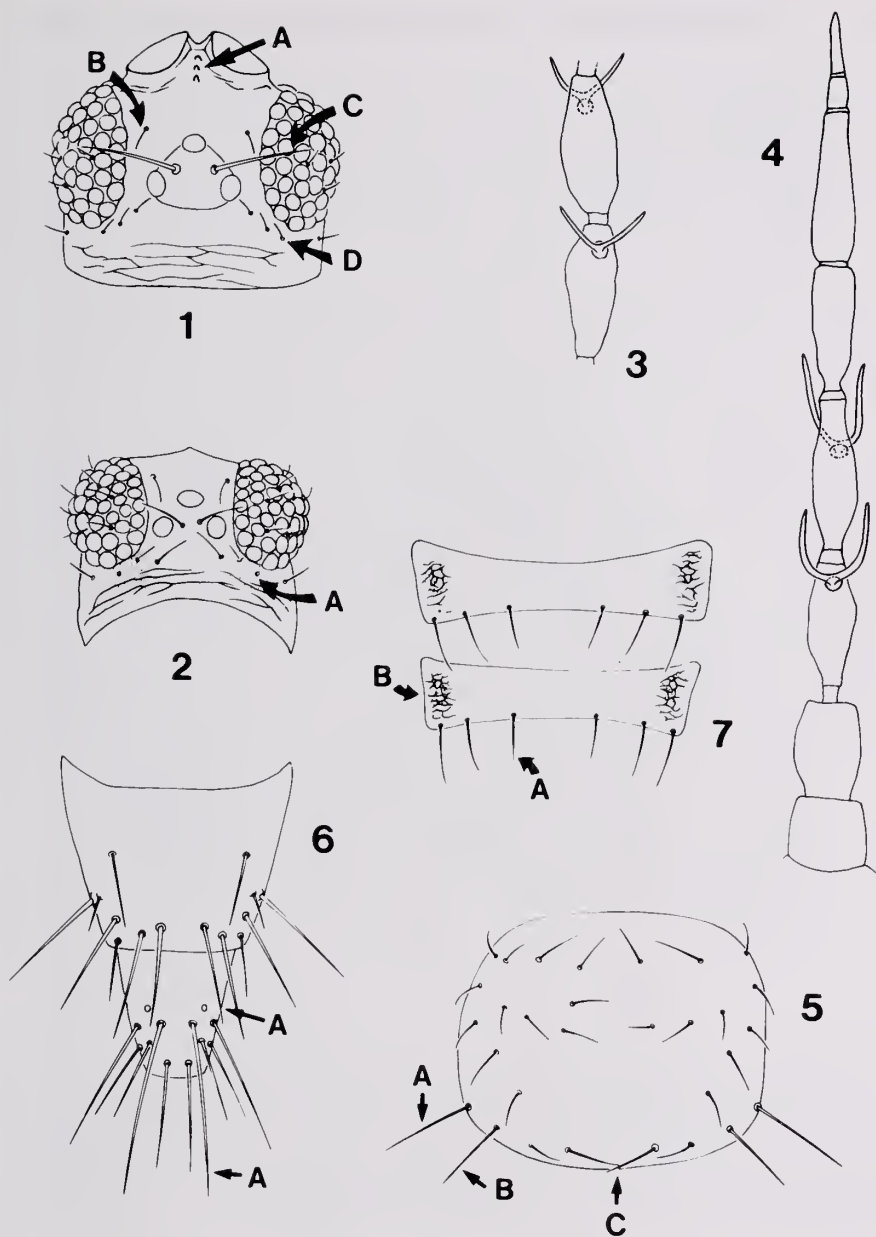
Taeniothrips cyperaceae Bianchi, 1945:283; Zimmerman, 1948:413; Jacot-Guillarmod, 1975:1001.

Dorcadothrips cyperaceae: Bhatti, 1978a:168.

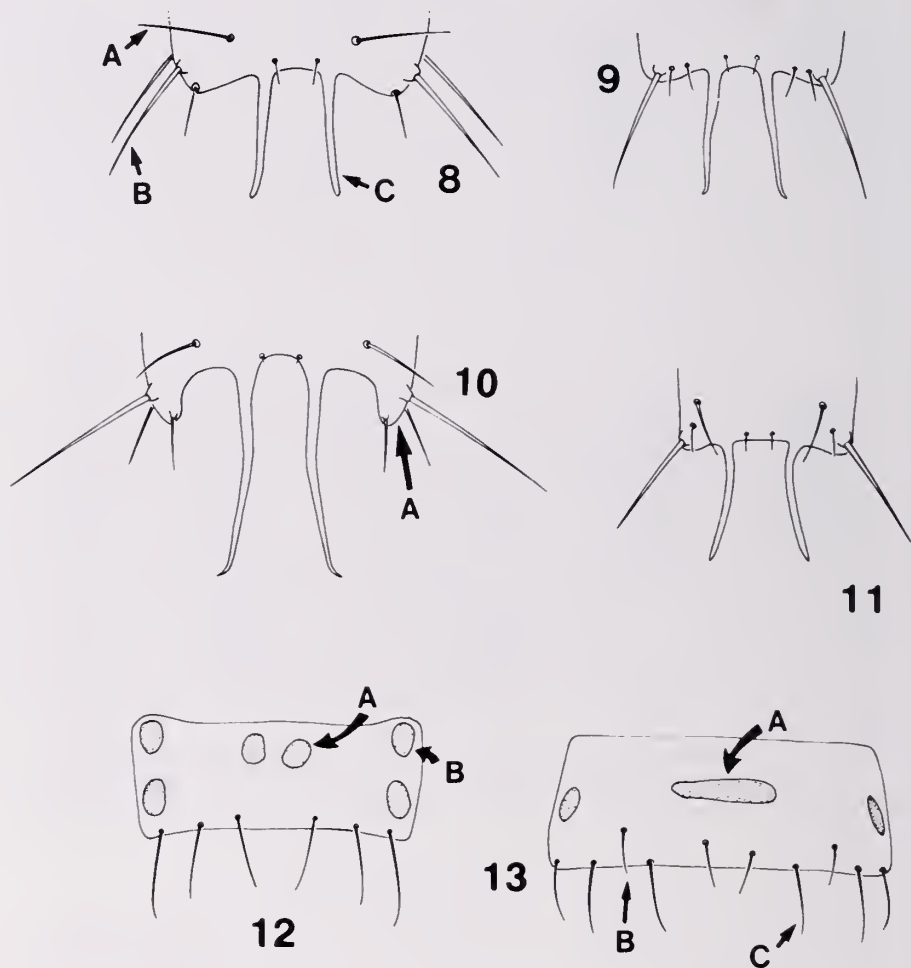
Dorcadothrips caespitis Priesner: Nakahara and Hilburn, 1989:255 (misidentification).

Female (macropterous): body yellow except for pale brown transverse band along and anterior of antecostal ridge on abdominal tergites II–VIII, widened on submargins, extending onto pleurotergites; legs pale yellow; ocellar crescent red; major body setae pale yellow or light brownish yellow; forewings completely pale with slight pale grayish shade in proximal $\frac{1}{2}$; antenna brown except segment I concolorous with head, basal $\frac{1}{2}$ of III and bases of IV–V pale.

Body length 1.26 (1.49 distended) mm (Bianchi 1945). Antennal segments III–IV not strongly constricted distal of subapical setae, trichomes on III–IV V-shaped, 22–24 long, slightly or not yoked at bases (Fig. 3); inner sense cones on VI about 24 long, on midlength or slightly anterior, extending to base of segment VII. Head (Fig.



Figs. 1-7. 1. *Dorcadothrips cyperaceae* female. Head. A. small anteromedial tubercles; B. ocellar seta II; C. ocellar seta III; D. postocular setae. 2. *Dorcadothrips oahuensis* female. Head. A. vestigial postocular seta (POiii). 3. *Dorcadothrips cyperaceae* female. Antennal segments III and IV. 4. *Dorcadothrips oahuensis* female. Antennal segments III and IV. 5. *Dorcadothrips oahuensis* female. Pronotum. A. outer posteroangular seta; B. inner posteroangular seta; C. posteromarginal seta. 6. *Dorcadothrips oahuensis* female. Abdominal tergites IX-X. A. B1 seta. 7. *Dorcadothrips xanthius* female. Abdominal sternites V-VI. A. major seta; B. submarginal brown area with rough callosities.



Figs. 8-13. 8. *Dorcadothrips cyperaceae* male. Abdominal tergite IX. A. dorsal seta; B. posterolateral seta; C. stout process. 9. *Dorcadothrips oahuensis* male. Abdominal tergite IX. 10. *Dorcadothrips walteri* male. Abdominal tergite IX. A. posterolateral lobe. 11. *Dorcadothrips xanthius* male. Abdominal tergite IX. 12. *Dorcadothrips oahuensis* male. Abdominal sternite V. A. submedial, oval glandular area; B. submarginal oval glandular area. 13. *Dorcadothrips walteri* male. Abdominal sternite VI. A. medial elongate glandular area; B. accessory seta; C. major seta.

1) with 3 small, anteromedial tubercles on vertex; ocellar setae II anterolaterad of anterior ocellus, setae III 50-54 long, extending from anterior of posterior ocelli to middle of eyes, inside ocellar triangle; ocelli rather small, posterior ones separated by about twice diameter of anterior ocellus; postocular setae 4, POiii shortest. Pronotum weakly sculptured, with 12-15 discal setae; posteroangular setae about $\frac{3}{5}$ as long as pronotum, outer pair 67-69 long, inner pair 67-69 long. Medial setae on

mesonotum anterior of posterior margin, aligned with submedial setae; metanotum without sensilla, medial setae posterior of anterior margin by about $\frac{1}{3}$ length of notum. Abdominal tergite I with reduced median setae, 1 lateral seta occasionally present on one side; sculpture extending to D2 setae on tergites II–VIII; B1 setae on IX about as long as tergite X; pleurotergites without accessory setae, minute microtrichia on sculpture lines; sternite I with 3 anteromedial setae, accessory setae on II–VII, 6–11 setae on VII.

Male (apterous): body length 1.19 mm from interantennal process. Body pale yellow, abdominal tergites IX–X darker grayish yellow, processes and genitalia yellowish brown; otherwise similar to female in color and most morphological structures. Antenna 271 long, length and width () of segment I 24(30), II 37(30), III 44(20), IV 47(17), V 37(17), VI 50(17), VII 12(8), VIII 20(5). Ocellar setae III about 37 long. Pronotal posteroangular setae outer pair 42–49 long, inner pair 44–47 long; posteroangular median pair about 35 long. Abdominal tergite I with median setae well developed, about 30 long, slightly longer than $\frac{1}{2}$ length of tergite, those on posterior tergites progressively shorter; D2 setae well developed as median or lateral setae on tergites II–VIII; tergites completely sculptured; tergite IX (Fig. 8) with stout processes 64 long, 5 wide at midlength, slightly curved before pointed apex; well developed dorsal setae, about 50 long; minute seta at base of each stout process; longer seta on slightly developed posterolateral lobe about 30 long; posterolateral seta 74 long, midlateral seta just anterior to posterolateral seta 67 long; sternites III–VII each with 4 accessory setae posterior of medial glandular area, sternite VIII with 7 accessory setae; medial glandular areas transversely elongate, about similar in width, 62 wide, anterior and posterior margins irregular, usually broadly narrowed; 2 oval glandular areas on each side along lateral margins.

Material examined: *Taeniothrips cyperaceae* Bianchi 2 paratypes, Honolulu, T. H., *Cyperus rotundus* L., 28–VIII–40, F. A. Bianchi. Honolulu, Hawaii, 9 females, 1 male, *Cyperus rotundus*, 11/15–XII–60, K. Sakimura; Riverside, California, 11 females, *Cyperus rotundus*, 18–X–82, D. W. Ricker & G. O. Proiner; Shelly Bay, Bermuda, 1 female, grass, 22–VI–88, D. Hilburn; Smith's, Bermuda, 1 female, *Bromus* sp., 22–VI–88, D. Hilburn (USNM).

Distribution: Bermuda, United States (California, Hawaii).

Hosts: *Bromus* sp., *Cyperus rotundus* L., grass, *Solanum nigrum* L., *Vinca minor* L.

Comments: The male of *D. cyperaceae* has not been described previously. The description presented here is based on one male collected in Honolulu, Hawaii on *Cyperus rotundus*.

This species belongs in the *D. caespitis* Priesner section of Bhatti (1978a:168) which includes three other species (*D. caespitis* Priesner from Egypt and Sudan, *D. obscuriceps* (Girault) from Australia and *D. walteri* (Crawford) from India and the United States) with accessory setae on the abdominal sternites. From *D. cyperaceae*, *D. caespitis* differs by having accessory setae on the abdominal pleurotergites; *D. obscuriceps* differs by having brown forewings similar to those of *D. xanthius* according to Mound and Houston (1987:6); and *D. walteri* differs by having a short, pale brown band on proximal $\frac{1}{3}$ of the forewings, lacks small anteromedial tubercles on the vertex of the head, and in the male, abdominal sternites III–VII each with 3 glandular areas. Conversely, *D. cyperaceae* has completely pale forewings, three small anter-

omedial tubercles on the vertex of the head, accessory setae absent from the abdominal pleurotergites and in the male, abdominal sternites III–VII each with five glandular areas.

Two collections of *D. cyperaceae* on *Bromus* and unknown grass in 1988 from Bermuda were misidentified by me (Nakahara and Hilburn, 1989:255) as *D. caespitis* Priesner. In the same article, *D. caespitis* was reported from Hawaii based on misidentified material of *D. cyperaceae* in the USNM collection.

Although first found on the island of Oahu, Hawaii, this species apparently was introduced from India or southeast Asia where 12 of the 18 known species in the genus occur.

***Dorcadothrips oahuensis*, new species**

Figs. 2, 4, 5, 6, 9, 12

Female (macropterous): body and legs pale yellow, head pale except eye light brown and light brown band extending posteriorly from each eye, reaching or not reaching posterior margin of head; ocellar crescents red; body setae pale yellow, setae on pronotum brownish yellow; forewing uniformly brown or apex paler, hindwing brown in basal $\frac{1}{4}$, with median longitudinal brown stripe. Antenna brown except almost all of segment II, basal $\frac{1}{2}$ of III, basal $\frac{1}{3}$ – $\frac{1}{2}$ of IV and basal $\frac{1}{3}$ of V pale yellow.

Body length measured from interantennal process, distended: 1.29 (1.18–1.37) mm.

Antenna (Fig. 4): segments III–VIII elongate; III constricted in basal $\frac{1}{4}$; IV strongly narrowed distally of subapical setae, somewhat parallel in distal $\frac{1}{4}$ of segment; VI gradually narrowed distally from base; VIII subparallel sided, about 4 times longer than wide. Trichomes on III–IV 32–35 (30–37) long, U-shaped, not yoked at base, those of III slightly longer than $\frac{1}{2}$ length of segment IV; inner sense cone on VI about 54 long, extending from basal $\frac{1}{4}$ of segment to about apex of VII. Total length 300(273–305); length and width () of holotype, segment I 24(27), II 37(27), III 52(17), IV 59(15), V 42(15), VI 54(15), VII 12(7), VIII 20(5); length and width () of paratypes, segment I 22–24(27), II 32–35(24), III 44–57(16–17), IV 49–62(15), V 42–44(15), VI 50–54(15), VII 12(7), VIII 18–22(5).

Head (Fig. 2): wider than long, eyes bulging, occiput almost straight, part behind eye less than $\frac{1}{2}$ as long as eye, with 2 complete transverse sculpture lines and several incomplete ones; small anteromedial tubercles absent from vertex; ocellar setae II anterolaterad of anterior ocellus, ocellar setae III between posterior ocelli, extending to about mesal margin of eye, closer to each other than width of anterior ocellus, 24(24–27) long; posterior ocelli separated by about width of anterior ocellus; 4 postocular setae, POiii vestigial, represented by porelike basal socket; mouthcone short, apically rounded.

Pronotum (Fig. 5): transverse, longer than head, weakly sculptured; discal setae few, about 27(25–28), longest 24(24–27); posteroangular setae $\frac{2}{5}$ to $\frac{1}{2}$ as long as pronotum, outer pair 47(42–52) long, inner pair 40–42(30–50) long; postermarginal setae 2 pairs, inner pair longest, 27(24–32) long; basantra without setae, ferna complete; propinasternum a transverse bandlike sclerite with posterior conical spina. Mesonotum: weakly sculptured, anteromedial sensilla absent, median setae near posterior margin, aligned with submedial setae. Metanotum: weakly sculptured, median setae slightly posterior of anterior margin, 2 sensilla close-set in about middle of notum. Spinula on mesothoracic sternum well developed.

Forewing: slightly concave on anterior margin; with 31(21–32) costal setae, 19(16–20) straight anterior fringe cilia; forevein with setae in groups of 3–2 (3–1 or 3–2) in proximal $\frac{1}{2}$, 2 setae in distal $\frac{1}{2}$; hindvein with 16(12–18) setae; scale with 4 marginal and 1 discal setae; forewing length 636(531–648), width at midlength 30(27–32).

Abdomen: median and D2 setae reduced on tergites I–VII; sculpture lines extending to D2 setae on tergites III–VII; tergite I with 1 pair of setae, lateral seta absent, rarely 1 on one side; tergite II with 3 lateral setae; B1 setae on tergite IX 64(44–72) long, slightly shorter than tergite X; tergite X 67(59–79) long, B1 setae 99(89–104) long (Fig. 6); pleurotergites without accessory setae, posterior margins with few small teeth; sternite I with 1–2 anteromedial setae; sternal accessory setae absent.

Male (macropterous): body length 1.21 mm from interantennal process, distended. Similar to female in color and most morphological characters.

Antenna total length 293; length and width () of segment I 24(24), II 30(24), III 54(15), IV 54(15), V 40(15), VI 59(12), VII 12(7), VIII 20(5). Ocellar setae III 27 long. Pronotal posteroangular setae outer pair 44–47 long, inner pair 40–44 long; posteromarginal medial pair 30–32 long. Forewing with 29 costal setae, 17 anterior fringe cilia; 2 groups of 3–2 setae on proximal $\frac{1}{2}$ of forevein, 2 setae in distal $\frac{1}{2}$; hindvein with 15–17 setae; forewing length 639–642, width at midlength 27–32. Median setae on abdominal tergite I reduced; tergites I–VII sculptured between median setae; abdominal tergite IX (Fig. 9) with anterior margin not emarginate; posterior margin not lobed laterally, with stout processes 69 long, 5 wide at midlength, separated at base by about 20, slightly sigmoid, narrowed apically and slightly curved before apex; 2 minute setae between bases of stout processes, 2 short setae between each stout process and posterolateral seta on each side 20–22 long; posterolateral setae 64–72 long; dorsal setae absent. Sternites III–VII each with 2 submedial, oval glandular areas in anterior $\frac{1}{2}$, 2 pairs of submarginal, longitudinally aligned glandular areas (Fig. 12).

Type material: Holotype female, allotype, 5 paratype females: Waimanalo, Hawaii, *Oncimum basilicum* L., 6-VI-91, D. Tsuda and R. Hamasaki, Holotype, allotype and 4 paratype females in USNM, 1 paratype female in Bishop Museum, Honolulu, Hawaii.

Etymology. Named after the island of Oahu in the state of Hawaii, the only known locality.

Comments: *Dorcadothrips oahuensis* belongs in the *D. hospes* section of Bhatti (1978a:168), which includes *D. xanthius* (Williams) treated here and six other species (*D. crispator* (Karny) from Indonesia, *D. hospes* (Karny) from Indonesia, *D. leptosperon* (Moulton) from New Guinea, *D. nilgircus* Ramakrishna and Margabandhu from India, *D. scindapsi* (Priesner) from Indonesia and *D. tenerimus* (Priesner) from Indonesia) with forewings uniformly brown, often paler apically, body either completely pale or parts brown, and abdominal sternites without accessory setae. *Dorcadothrips oahuensis* differs from its seven congeners by having rather long U-shaped trichomes on antennal segments III–IV, body pale yellow except for the brown area posterior of each eye, POiii seta vestigial and male with three pairs (one medial, two lateral) of glandular areas on abdominal sternites III–VII.

Although this species is known only from Hawaii, it is probably adventive from southeast Asia.

Dorcadothrips walteri (J. C. Crawford)

Figs. 10, 13

Taeniothrips walteri Crawford, 1941:142.*Dorcadothrips nevini* Hood, 1941:145.*Dorcadothrips caespitis* Priesner: Ananthakrishnan, 1965:28 (misidentification according to Bhatti, 1990:227).*Dorcadothrips walteri*: Stannard, 1968:306; Jacot-Guillarmod, 1974:750; Bhatti, 1990:227.*Dorcadothrips indicus* Bhatti, 1978a:423, Bhatti, 1990:227.

Female (macropterous): body yellow except grayish brown on sides and spiracular area of mesothorax, abdominal tergites II–VIII light brown anterior of antecostal ridge and in submarginal area, pleurotergites almost completely light brown; legs pale yellow; ocellar crescent orange-red; setae light yellow; forewing shaded pale grayish brown, with a short, slightly darker grayish brown band at proximal $\frac{1}{3}$ of wing, paler distally; antennae grayish brown except segment I pale as head, basal $\frac{1}{2}$ of III and bases of IV–V pale.

Body 1.5 mm long (distended). Antennal segment IV not strongly constricted distally of subapical setae, trichomes on III–IV distinctly yoked or not yoked at base, Y- or V-shaped, 30–37 long; inner sense cone on VI anterior of midlength of segment, 24–30 long. Head with eyes bulging, occiput almost straight; small anteromedial tubercles absent from vertex; ocellar setae II anterolaterad of anterior ocellus, ocellar setae III about 54 long, aligned with anterior margin of posterior ocelli or slightly anterior, inside ocellar triangle, extending over eye; 2 postocular setae normally mesad of eye and 1 toward margin of head, or occasionally 3 mesad of eye. Pronotum with 18–22 discal setae, in anterior and medial transverse rows; posteroangular setae 60–70 long, $\frac{1}{2}$ – $\frac{3}{5}$ as long as pronotum; metanotum without sensilla, median setae posterior of anterior margin by about $\frac{1}{5}$ of notum. Abdominal tergite I with well developed or reduced median setae, lateral seta absent; B1 setae on tergite IX slightly shorter than tergite X; pleurotergites without accessory setae; abdominal sternite I with 1–2 anteromedial setae; accessory setae on sternites II–VII, 2–8 on VII.

Male (apterous): body length 1 mm. Similar to female in most morphological characters, paler. Abdominal tergites completely sculptured; median setae on tergite I–VII well developed, on I 27–37 long; D2 setae on II–VIII as well developed as median and lateral setae; anterior margin of abdominal tergite IX emarginate, posterior margin strongly lobed laterally (Fig. 10), stout processes 94–110 long, broadly but slightly curved laterally, ending apically with sharper curve; dorsal setae well developed, 42–54 long; minute seta at base of each stout process; posterolateral setae 74–86 long on lateral margin of posterolateral lobe, a shorter setae 27–37 long on inner margin of lobe near apex; abdominal sternites III–VII (Fig. 13) with 1 transversely elongate medial glandular area, 1 oval glandular on each side, occasionally 2 glandular areas on 1 side; 1–5 accessory setae posterior of medial glandular area, 5 accessory setae on VIII.

Material examined: *Taeniothrips walteri* Holotype, 8 paratypes, Kalamazoo, Michigan, midcrease grass blade, 6-X-40, J. E. Walter; *Dorcadothrips nevini* Hood, Holotype, allotype, 23 paratypes, Ringwood, Tompkins County, New York, grass in

bog, 4-X-40, F. R. Nevin. Kilroy State Park, Tyler, Texas, 1 female, 22-V-84, Woolley coll.; Hubli, India, 4 females, ex grass, 16-I-64, TNA No. 127 (USNM).

Distribution: India, United States (Illinois, Michigan, New York, Texas).

Hosts: *Andropogon* sp., grass.

Comments: *Dorcadothrips walteri* was described from Michigan and the junior synonym, *D. nevini*, was described from New York state. According to Bhatti (1990: 227), *D. walteri* occurs in five states in India and was previously known in India as *D. indicus* or misidentified as *D. caespitis*.

This species and *D. cyperaceae* (Bianchi) have accessory setae on the abdominal sternites and belongs in the *D. caespitis* section of Bhatti (1978a:168). The differences between these species are discussed in the comments for *D. cyperaceae*.

Dorcadothrips xanthius (Williams)

Figs. 7, 11

Physothrips xanthius Williams, 1917:59.

Taeniothrips (*Physothrips*) *xanthius*: Watson, 1924:41.

Taeniothrips xanthius: Moulton, 1933:130; Jacot-Guillarmod, 1975:1064.

Dorcadothrips xanthius: Bhatti, 1978a:168.

Female (macropterous): body generally pale yellow; head brown at eyes and between eyes to anterior margin, pale yellow posterior of eyes; abdominal sternites V–VI with submarginal brown area on each side (Fig. 7), brown area usually present on sternite IV; legs pale yellow; setae light yellow; ocellar crescent red; forewing uniformly brown, paler at apex; antenna brown except paler in basal ½ of segment II, pale in basal ½ of III, ⅓ of IV, ¼ of V and base of VI.

Antennal segment IV strongly constricted distally of subapical setae (cf. Fig. 4), III–IV with long, U-shaped trichomes not yoked at base, 32–42 long, VI with inner sense cone on about midlength, extending to segment VIII. Head lacking small anteromedial tubercles on vertex; ocellar setae II anterolaterad of anterior ocellus, ocellar setae III about 27 long, aligned with anterior margin of posterior ocelli or between posterior ocelli, closer to each other than diameter of anterior ocellus, extending to mesal margin of eyes; posterior ocelli separated by about width of anterior ocellus; 4 pairs of postocular setae, POiii shorter than POi-ii. Pronotum with 22–25 discal setae; posteroangular setae 32–44 long, ⅓ to less than ½ as long as pronotum. Metanotum with median setae near anterior margin; 2 sensilla about midlength or slightly anterior on notum. Abdominal tergites with median setae reduced; tergite I without lateral seta; sculpture lines not extending to D2 setae on III–VIII; B1 setae on tergite IX shorter than tergite X; pleurotergites without accessory setae; abdominal sternite I with 1–2 anteromedial setae; accessory setae absent from sternites; submarginal brown area with rough callosity on each side of sternites V–VI (Fig. 7).

Male (macropterous): body length 1 mm from interantennal process. Similar to female in color and most morphological structures (submarginal brown areas on abdominal sternites V–VI not observed). Antenna 266 long; length and width () of segment I 22(24), II 32(27), III 42(17), IV 47(17), V 37(15), VI 54(15), VII 12(7), VIII 20(5). Ocellar setae about 24 long. Pronotal posteroangular setae 32 long, posteromarginal setae medial pair 22 long. Forewing 551 long, 35 wide at midlength; with 21 costal setae, 14 anterior fringe cilia, hindvein with 10 setae. Median setae

on abdominal tergite I reduced; tergites completely sculptured; tergite IX (Fig. 11) with straight anterior margin; stout processes 64 long, 5 wide at midlength, extending posteriorly, curved outward; dorsal setae 30 long, posterolateral setae 59–67 long, a setae between dorsal setae and posterolateral seta about 12 long. Abdominal sternites III–VIII with a median, transversely elongate glandular area and two small, oval, submarginal glandular areas on each side.

Material examined: *Physothrips xanthius* Williams 1 Co-type and 1 Paratype; Trinidad, Port-of-Spain, on orchids, 1916, F. W. Urich (C. B. Williams No. 772). Trinidad, Port-of-Spain, 1 female, 1 male, orchid, 17-IV-16, C. B. Williams; Trinidad, Port-of-Spain, 5 females, 2 males, orchids, X-15, F. W. Urich; New York, New York (New York Botanical Garden) 13 females, 1 male, 29-X and 3-XII-32, J. Saitta. (USNM). Other females examined from Australia, Belgium, England, Puerto Rico, Trinidad and the United States (California, Hawaii, Kentucky, Maryland, New York and Oregon) from various orchids grown mainly in greenhouses. These collections are 50 years or older and very likely this species may not occur in some of these localities.

Distribution: Australia, Belgium, Brazil, England, Korea, Japan, Puerto Rico, Trinidad, United States (California, Florida, Hawaii, Kentucky, Maryland, New York, Oregon).

Hosts: *Cattleya* sp., *Cypripedium* sp., *Laelia* sp., *Odontoglossum* sp., orchids.

Comments: The male of *D. xanthius* has not been described previously. The description presented here is based on a male collected in New York Botanical Garden in 1932 and three males from Trinidad collected in 1915 and 1916.

This species also belongs in the *D. hospes* section of Bhatti (1978a). It differs from *D. oahuensis*, another member of the section, by the brown submarginal area with a roughen callosity on each side of abdominal sternites V–VI in the females, and the males with a transverse, elongate medial glandular area on abdominal sternites III–VII. The female of *D. oahuensis* has completely pale sternites V–VI and lacks rough callosities and the males have two oval submedial glandular areas on sternites III–VII.

Although this species was first found in Trinidad, it is probably adventive and may have been introduced on orchids from southeast Asia where most of the species in the *D. hospes* section are known.

ACKNOWLEDGMENTS

I am grateful to the following reviewers for their constructive comments and suggestions: R. J. Beshear, University of Georgia, Griffin; D. Tsuda, University of Hawaii, Honolulu; and D. R. Smith, Systematic Entomology Laboratory, Washington, D.C., and R. L. Smiley, same laboratory, Beltsville, Maryland. The illustrations were prepared by L. H. Lawrence, Systematic Entomology Laboratory.

LITERATURE CITED

- Ananthakrishnan, T. N. 1965. Indian Terebrantia—II (Thysanoptera: Insecta). Bulletin of Entomology 6:15–29.
Bhatti, J. S. 1978a. A preliminary revision of *Taeniothrips* (Thysanoptera: Thripidae). Oriental Insects 12(2):157–199.

- Bhatti, J. S. 1978b. Four new species of Thysanoptera from India. *Oriental Insects* 12(3):419–432.
- Bhatti, J. S. 1990. Catalogue of insects of the order Terebrantia from the Indian Subregion. *Zoology* 2(4):205–352.
- Bianchi, F. A. 1945. Notes on Hawaiian Thysanoptera, with description of a new species. *Proceedings of the Hawaiian Entomological Society* 12(2):279–286.
- Crawford, J. C. 1941. A new *Taeniothrips* from Michigan (Thysanoptera). *Proceedings of the Entomological Society of Washington* 43(6):142–143.
- Hood, J. D. 1941. A century of new American Thysanoptera. II. *Revista de Entomologia, Rio de Janeiro* 12(1–2):139–243.
- Jacot-Guillarmod, C. F. 1974. Catalogue of the Thysanoptera of the world. Part 3. *Annals of the Cape Provincial Museums (Natural History)* 7(3):517–976.
- Jacot-Guillarmod, C. F. 1975. Catalogue of the Thysanoptera of the World. Part 4. *Annals of the Cape Provincial Museums (Natural History)* 7(4):977–1255.
- Moulton, D. 1933. The Thysanoptera of South America (II). *Revista de Entomologia, Rio de Janeiro* 3(1):96–133.
- Mound, L. A. and K. J. Houston. 1987. An annotated checklist of Thysanoptera from Australia. *Occasional Papers on Systematic Entomology* 4:1–28.
- Nakahara, S. and D. J. Hilburn. 1989. Annotated checklist of the Thysanoptera of Bermuda. *Journal of the New York Entomological Society* 97(3):251–260.
- Priesner, H. 1932. Contribution towards a knowledge of the Thysanoptera of Egypt VII. *Bulletin de la Société Royal Entomologique d’Egypte* 16:45–51.
- Stannard, L. J. 1968. The thrips, or Thysanoptera, of Illinois. *Illinois Natural History Survey Bulletin* 29(4):215–552.
- Watson, J. 1924. Synopsis and catalog of the Thysanoptera of North America. University of Florida Agricultural Experiment Station Technical Bulletin 168:1–100.
- Williams, C. B. 1917. A new thrips damaging orchids in the West Indies. *Bulletin of Entomological Research* 8:59–61.
- Zimmerman, E. C. 1948. *Insects of Hawaii*, vol. 2. University of Hawaii Press, Honolulu, 475 pp.

Received 5 May 1992; accepted 12 August 1992.

**LESTES SECULA, A NEW SPECIES OF DAMSELFLY
(ODONATA: ZYGOPTERA: LESTIDAE) FROM PANAMA**

MICHAEL L. MAY

Department of Entomology, New Jersey Agricultural Experiment Station,
Cook College, Rutgers University, New Brunswick, New Jersey 08903

Abstract.—The new species most closely resembles *Lestes tenuatus*, *L. pictus*, and *L. henschawii*, but it is distinctive in color pattern, in the form of the male cerci, and in the form of the ovipositor. Brief notes on its ecology and probable relationships, as well as a key to regional species, are provided.

Resumen.—La nueva especie se parece a *Lestes tenuatus*, *L. pictus*, y *L. henschawii*, pero es distintiva en su coloración y en la forma de los cercos del macho y del ovipositor. Se provee, además, breves notas acerca de sus ecología y probables relaciones específicas, así como una clave para identificar las especies de la región.

Key Words: Central America, *Lestes*, neotropical fauna, Panama, Zygoptera

The Zygoptera of the Neotropics, although better studied than most tropical insects, are still poorly known. Merely to catalog the diversity of that region is a monumental task facing biologists over the next decades. What follows is intended as a small contribution to that effort.

The genus *Lestes* is cosmopolitan, and one of the largest zygopteran genera; 88 species are recognized by Tsuda (1991), 23 of which are Neotropical. *Lestes* has not been treated comprehensively, but Calvert (1901–1908, 1909) and Kennedy (1942) clearly illustrated diagnostic features for males of many species. Comparison with descriptions and/or authoritatively identified specimens of all the regional species confirm that the species described here is new.

TERMINOLOGY AND METHODS

Terminology for the caudal appendages follows Snodgrass (1954), for the penis Miller and Miller (1981), and for the wing veins Tillyard and Fraser (1938–1940).

All measurements are in mm and were made with a ruler (to 0.5 mm) or a filar micrometer (to 0.1 or 0.01 mm). Total length and abdomen length include the cerci. Cerci and paraprocts were measured in lateral view from about mid-height of each (not from a common point) to its tip. Ovipositor lengths exclude the styli. Illustrations were modified from sketches made using a Wild stereo microscope equipped with a camera lucida and/or tracings of electron micrographs made with an Hitachi S-510 scanning electron microscope. Specimens are preserved dry in transparent envelopes unless otherwise noted.

Collections referred to are abbreviated as follows: FSCA—Florida State Collection of Arthropods (Gainesville); IORI—International Odonata Research Institute (Gainesville); MLM—personal collection of M. L. May (New Brunswick); MCZ—Museum of Comparative Zoology (Cambridge, MA).

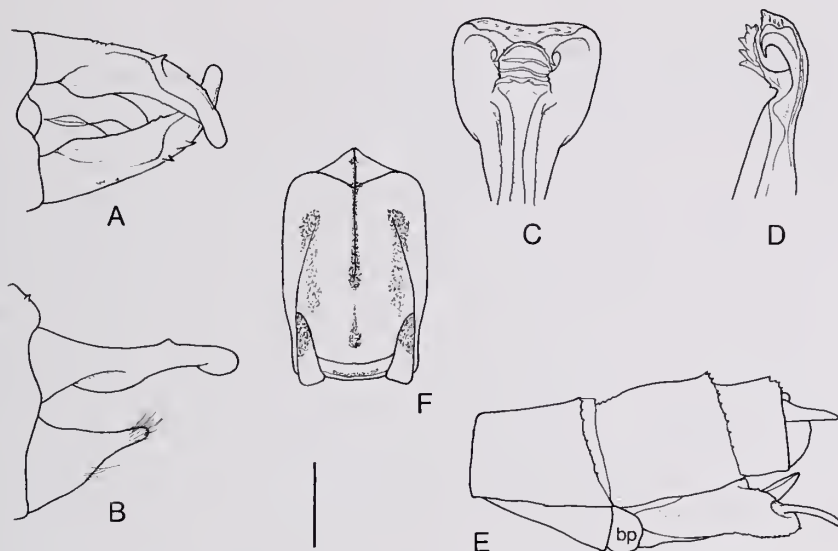


Fig. 1. *Lestes secula* spec. nov. A—male caudal appendages, dorsal view; B—male caudal appendages, lateral view, right appendages omitted; C—head and distal shaft of penis, ventral view; D—head and distal shaft of penis, lateral view; E—apex of female abdomen, lateral view (bp—basal plate of ovipositor); F—diagram of color pattern on ventral metathorax. Scale bar = 0.5 mm for A, B; 0.3 mm for C, D; 1.0 mm for E.

Lestes secula, new species

Fig. 1A–F

Material examined.—Holotype: ♂ (#1), Panama, Area del Canal, Barro Colorado Island, seasonal pond at Standley Trail marker 5, 28 March 1974, coll. by M. L. May, IORI. Allotype: ♀ (#2), same data as holotype except 19 January 1974. Paratypes: 1 ♂ (#3), Panama, Prov. Panama, Pacora, 24 December 1950, coll. by R. B. Cumming, FSCA; 1 ♂ (#4), 1 ♀ (#5), same data as holotype except 9 Feb. 1972, teneral specimens preserved in alcohol, MLM; 1 ♂ (#6), 2 ♀ (#'s 7, 8), same data as holotype except collected as larvae on 15 September 1974 (♂ emerged 22 Sept., ♀'s emerged 20 and 23 Sept.), preserved in alcohol, FSCA.

Etymology.—*Secula* is the Latin noun for sickle, or scythe, referring to the shape of the male cerci.

Diagnosis.—A species of moderate size and stature, dark and not strongly metallic or pruinose; the posterior surface of the head is mostly black, the medial mesepisternal dark stripe at least $\frac{1}{2}$ width of that sclerite, and distinct dark markings are present above and below the metapleural carinae and on the thoracic venter (Fig. 1F). The shape of the male cerci is unique; the paraprocts are unusually short and stout (Fig. 1A, B). The ventral margin of the ovipositor is distinctly concave and the basal plate rounded (Fig. 1E).

Males of *L. secula* resemble *L. tenuatus* in the form of their paraprocts and in size

and general coloration but are usually darker insects with wider and less brightly metallic mesepisternal stripes (dark thoracic areas of some old male *L. tenuatus* may be as extensive as in *L. secula*, however), a more extensive dark pattern on the metathoracic venter, and the rear of the head dark. They ordinarily are easily distinguished by the absence of a basal tooth along the medial margin of the cerci, although this tooth may occasionally be blunt and lobe-like in *L. tenuatus* (Johnson, 1975). Females are very similar to *L. tenuatus* in the form of the ovipositor and the slightly flavescent wings but are stockier (in *L. tenuatus* abdominal segment 3 is at least 6 times as long as its height at midlength) and differ in the same color characters.

Both sexes of *L. secula* also are somewhat like *L. henschawi*, a species not recorded from Panama but expected to occur (Tsuda, 1991). *Lestes henschawi* is an appreciably larger species, however (hindwing longer than 25 mm, abdomen longer than 36 mm in males, 33 mm in females), with the pronotum largely black, black areas of the pterothorax lacking greenish reflections, and pale areas of the pterothorax contrasting sharply with the black and apparently not becoming brown and obscure. Like *L. tenuatus*, male *L. henschawi* have a distinct basal tooth on the inner edge of the cerci. The ovipositor of female *L. henschawi* resembles both *L. secula* and *L. tenuatus* in having a rounded basal plate but differs from both those species in that the ventral margins of the third valvulae are nearly straight, not distinctly concave.

The absence, as in *L. secula*, of a basal cercal tooth is uncommon among male *Lestes* and mostly occurs in species with a distinct declivity toward the apex of the cerci. An exception is *L. pictus* Hagen in Selys. In this South American species, however, the medial shelf of each cercus is wider apically (Calvert, 1909; Muzon, pers. comm., 1991) than in *L. secula*, and in the male syntype (which now lacks its terminal abdominal segments; pers. obs., 1988) the rear of the head is pale, and the dorsum of abdominal segment 2 has a wider, triangular pale stripe. The female syntype also has the rear of the head pale and the ventral margin of the ovipositor straight; a female in the Carnegie Museum (Pittsburgh, PA) has the ovipositor barely concave, with the basal plate right-angulate.

Holotype.—Abdomen broken between segments 4 and 5, both hind tarsi broken off, subapical tear in both forewings.

Head with labrum light blue with narrow brown margin and small mediobasal spot. Genae and outer surface of mandible ivory with slight bluish cast. Clypeus broadly brown along clypeolabral and epistomal sutures, black between. Antefrons brown ventrally, becoming black above; remainder of epicranium black with slight metallic greenish reflections except for small brown areas just lateral to lateral ocelli and on occipital ridge. Antennae black to dark brown with tan anterior stripe on 2 basal segments, ocelli brown, eyes grey (probably bluish in life). Rear of head black except small yellowish central area, mouthparts tan with apices of mandibles and maxillae black.

Prothorax brown with small, geminate black spot on middle lobe; slightly pruinose dorsally, heavily so on pleura. Pterothorax with middorsal carina and narrow flanking stripes, antealar ridge and sinus, and tergal sclerites brown. Mesepisterna each with black stripe, showing metallic greenish reflections, extending their full length and gradually widening from about $\frac{1}{2}$ width of sclerite anteriorly to $\frac{2}{3}$ width at posterior end. Laterally and ventrally, thorax largely brown, slightly darker on center of mesepimeron, yellowish tan on ventral mesinfraepisternum, anterior metepisternum, lateral

metepimeron, and venter; pattern of dark ventral and ventrolateral markings like Figure 1F but nearly obscured along midline by pruinosity. Also heavily pruinose on coxae and anterior tergal sclerites, lightly so along metapleural and interpleural sutures. Legs tan, brown on extensor surfaces of femora, black on internal and external angles and distal ends of femora, flexor surfaces of tibiae, and most of tarsi. Wings hyaline, veins and pterostigmata black to dark brown.

Abdomen with terga of segments 1–8 black with slight metallic greenish reflections dorsally except grey on basal $\frac{1}{3}$ and distal $\frac{1}{6}$ of segment 1, tan along diffuse, narrow median line on 2, extremely narrow hairline on 3 and 4, and narrow, medially interrupted basal rings on 3–8. Tergites tan ventrolaterally except for black apical annulus on each and black ventral margin of 1, marginal spot of 2, and edges of hamules. Segments 9 and 10 dark red-brown, dorsal apex of 10 black; caudal appendages mostly black. Sternum of segment 1 tan with median black stripe, 2–7 black, 8 and 9 each brown with median black line. Third abdominal segment 10 times as long as its height at midlength, 2.5 times as long as segment 2. Cerci 1.12 mm, lacking prominent teeth along medial edges, each with shelf-like medial dilation along distal $\frac{4}{5}$ that is widest near base and gradually tapers to apex; paraprocts 0.66 mm, slightly upcurved, with terminal tuft of setae (Fig. 1A, B). Penis not extruded but presumably as in Figure 1C, D.

Measurements: Total length—37.0, abdomen—29.0, hindwing—21.0.

Allotype.—Left prothoracic leg broken at trochanter, abdominal segment 9 indented dorsally.

Head and prothorax as in holotype except labrum dull, dark grey. Pterothorax with mesepisternum similar to holotype but middorsal carina darker and less distinct from black stripe, antealar ridge and sinus dark. Mesepimeron dark brown with black streak about $\frac{2}{3}$ its width along central $\frac{3}{5}$. Mesinfraepisternum black on dorsal $\frac{1}{2}$, yellowish ventrad. Metapleura and venter yellowish-tan with dark line along each metapleural sulcus and along anterodorsal margins of metinfraepisternum. Dark markings of venter similar to holotype but much less obscured by pruinosity. Legs and wings as in holotype except wing membranes faintly flavescent.

Abdominal segments 1–7 marked much as in holotype but dark areas generally more extensive. Pale ventrolateral areas of segments 1 and 2 with distinct greenish-grey tint, those of 3–7 darker than in holotype. Segments 8–10 entirely dark brown to black except small, ventrolateral tan markings on 8. Third abdominal segment 5 times as long as its height at midlength, 2.1 times as long as segment 2. Ovipositor 2.25 mm, with ventral margin of valvula 3 distinctly concave near midlength, basal plate rounded (Fig. 1E).

Measurements: Total length—37.5, abdomen—29.5, hindwing—22.0.

Variation among paratypes.—Male from Pacora like holotype except generally darker, hence probably older. Postclypeus entirely dark. Pterothorax marked as in allotype except lateral dark areas more extensive and ventrolateral margins darker; venter with less pruinosity, more extensive dark marking than holotype. Abdomen with middorsal lines obsolete, lateral areas of segment 1 entirely margined with black. Penis shown in Figure 1C, D. Total length—38.0, abdomen—30.0, hindwing—22.0.

The teneral and reared specimens, in alcohol, have very faintly developed color patterns. They appear similar to those of the holotype and allotype, except with the mesepisternal dark stripe slightly narrower, probably a function of age. Structurally

they seem identical. Measurements are not given because of the probability of distortion of the soft cuticle.

Notes.—Like many *Lestes*, this species inhabits seasonal ponds with abundant bottom litter and no fish. The type locality is typically dry from about February to May or June. It is in old-growth, seasonal moist forest, receives sunlight only intermittently except at midday, and has little or no rooted aquatic vegetation. Seemingly mature *L. secula* could be found throughout most of the year, but I observed reproductive activity only during the wet season. Possibly this species, like a number of other tropical dragonflies, passes the dry season in adult diapause. Other Odonata collected at the type locality included *Miocora peraltica* Calvert (probably not breeding), *Metaleptobasis westfalli* Cumming, *Neoerythromma cultellatum* (Selys), *Gynacantha gracilis* (Burmeister), *G. tibiata* Karsch, *Triacanthagyna satyrus* (Martin), *Anatya normalis* Calvert, *Cannaphila insularis* Kirby, *Erythrodiplax fervida* (Erichson), *Micrathyria atra* (Martin), and *Perithemis mooma* Kirby. In Panama, *L. tenuatus* Rambur is common in similar habitats but was not collected with *L. secula*.

KEYS TO *LESTES* OF MEXICO AND CENTRAL AMERICA

The following should permit identification of adults of all the species known from Mesoamerica. The validity of *L. simplex* as distinct from *L. alacer* was questioned by Johnson (1972) and remains unresolved; the couplet separating these two is taken almost directly from Johnson's key. The female of *L. simplex* is undescribed. The Antillean species, *Lestes scalaris* Gundlach, was reported from this area by Dunkle (1990), possibly because of its close similarity to *L. tikalus* Kormondy; although I, too, am uncertain that the latter is distinct, I provisionally retain the name *tikalus* for the mainland populations.

Males

- 1 Paraprocts sigmoid, their tips diverging *sigma*
- 1' Paraprocts not sigmoid, their tips parallel or converging 2
- 2(1') Cerci, in dorsal view, scythe-like, their medial margins without large teeth (Fig. 1A) *secula*
- 2' Cerci not so, their medial margins with at least one prominent tooth 3
- 3(2') Paraprocts barely more than $\frac{1}{2}$ length of cerci, or less 4
- 3' Paraprocts distinctly more than $\frac{1}{2}$ (typically more than $\frac{2}{3}$) length of cerci 5
- 4(3) Femora and posterior surface of head mostly yellow to yellow brown (head darkens with age); mesepisterna each with metallic green stripe, not contiguous with mid-dorsal carina (middorsal area may become dark brown) *tenuatus*
- 4' Femora and posterior surface of head mostly black; mesepisterna each with uniformly black stripe, contiguous with middorsal carina *henshawii*
- 5(3') Cerci, in dorsal view, with distinct subapical, medial tooth in addition to similar basal tooth; metallic green mesepisternal stripe abruptly widened posteriorly ... *tikalus*
- 5' Cerci, in dorsal view, with basal, medial tooth only, usually followed by more or less serrated margin; mesepisternal stripe uniform in width or only slightly and gradually widened posteriorly 6
- 6(5') Mesepisterna each with narrow, metallic green stripe, not contiguous with middorsal carina, paraprocts nearly as long as cerci, extending well beyond posterior limit of medial dilation of latter *forficula*
- 6' Mesepisterna each with broad black stripe, contiguous with middorsal carina; par-

- aprocts not more than $\frac{3}{4}$ as long as cerci, extending little, if at all, beyond posterior limit of medial dilation of latter 7
- 7(6') Cerci, in dorsal view, with medial serrated dilation a well-developed lobe terminated posteriorly by a distinct notch; paraprocts not distinctly curved inward *alacer*
- 7' Cerci, in dorsal view, with medial serrated dilation less prominent, not terminating posteriorly in a distinct notch; paraprocts distinctly curved or slanted inward ... *simplex*

Females

- 1 Basal plate of ovipositor rounded at posteroventral margin; ventral margin of valvula 3 of ovipositor often with distinct concavity (Fig. 1E; not so in *L. henshawi*) 2
- 1' Basal plate of ovipositor with posteroventral corner acutely angulate, often with an acute tooth; ventral margin of valvula 3 of ovipositor nearly straight to convex throughout 4
- 2(1) Posterior surface of head yellow or yellow brown; thoracic venter without dark streak along metapleural carina; length of abdominal segment 3 about 6 times its height at midlength *tenuatus*
- 2' Posterior surface of head black; thoracic venter with dark streak just ventromedial to metapleural carina, in addition to dark anterior and posterior spots adjacent to carina (Fig. 1F); length of abdominal segment 3 about 5 times its height at midlength 3
- 3(2') Ventral margin of valvula 3 of ovipositor with distinct concavity; pale stripes of mesothorax often not sharply demarked and dark mesepimeral stripes either much shorter than mesepimeron or largely brownish and obscure; pronotum not black; hindwing shorter than 25 mm *secula*
- 3' Ventral margin of valvula 3 of ovipositor nearly straight; pale stripes of mesothorax sharply demarked and dark mesepimeral stripes black and extending almost full length of mesepimeron; pronotum largely black; hindwing usually longer than 25 mm *henshawi*
- 4(1') Mesepisterna with distinctly metallic green stripes or spots 4
- 3' Mesepisterna without metallic green areas, dark areas black, sometimes with bronze reflections 5
- 4(3) Mesepisternal stripe usually wider than 0.3 mm at narrowest point, abruptly expanded posteriorly; metallic green mesepimeral stripe, if present, wedge-shaped, widest anteriorly *tikalus*
- 4' Mesepisternal stripe usually narrower than 0.3 mm at narrowest point, only slightly and gradually widened posteriorly; metallic green mesepimeral stripe, if present, linear *forficula*
- 5(3') Mesepisterna and mesepimera with dark spots or streaks extending much less than length of each sclerite or, in old specimens, entire mesothorax becoming dark and heavily pruinose *sigma*
- 5' Mesepisterna and mesepimera with complete, dark stripes extending nearly full length of respective sclerites, this pattern never entirely obscured *alacer*

ACKNOWLEDGMENTS

My sincere thanks to Drs. S. W. Dunkle and M. J. Westfall for giving me free access to the IORI and FSCA collections, to Dr. John Rawlins for access to the collection of the Carnegie Museum, to Dr. Scott Shaw for permission to examine the types of *L. picta* at the MCZ, and to Dr. Mark O'Brien of the University of Michigan Museum of Zoology for the loan of Kennedy's plesiotype female of *L. henshawi*. Drs. R. Garrison and J. Muzon generously provided information on species not available to me and critically read the manuscript. Finally, I thank Dr.

R. B. Cumming, who collected this species before I did, for the privilege of describing it. New Jersey Agricultural Experiment Station Publication D-08425-08-92.

LITERATURE CITED

- Calvert, P. P. 1901-1908. Neuroptera. Odonata. *In*: F. D. Godman and O. Salvin (eds.), *Biologia Centrali Americani*. Porter and Dulau, London.
- Calvert, P. P. 1909. Contributions to a knowledge of the Odonata of the Neotropical region, exclusive of Mexico and Central America. *Ann. Carnegie Mus.* 6:73-280.
- Dunkle, S. W. 1990. Damselflies of Florida, Bermuda, and the Bahamas. Scientific Publishers, Gainesville, FL.
- Johnson, C. 1972. The damselflies (Zygoptera) of Texas. *Bull. Florida State Mus.* 16:55-128.
- Johnson, C. 1975. Variability in the damselfly, *Lestes sigma* Calvert (Zygoptera: Lestidae). *Texas J. Sci.* 26:165-169.
- Kennedy, C. H. 1942. *Lestes henshawi*, Ecuador, L. urubamba, Peru, and notes on other South American *Lestes* (Lestidae: Odonata). *Rev. Ent.* 13:274-290.
- Miller, P. L. and C. A. Miller. 1981. Field observations on copulatory behavior in Zygoptera, with an examination of the structure and activity of the male genitalia. *Odonatologica* 10:201-218.
- Snodgrass, R. E. 1954. The dragonfly larva. *Smith. Misc. Coll.* 123:1-38.
- Tillyard, R. J. and F. C. Fraser. 1938-1940. A reclassification of the order Odonata based on some new interpretations of the venation of the dragonfly wing. *Austr. Zool.* 9:125-169, 195-221, 359-390.
- Tsuda, S. 1991. A Distributional List of World Odonata. Osaka.

Received 5 June 1992; accepted 15 October 1992.

**DISCOVERY OF THE TYPES OF
PLATISTUS SPINICEPS (HERRICH-SCHÄFFER, 1840) AND
AGROECUS SCABRICORNIS (HERRICH-SCHÄFFER, 1844),
WITH A REDESCRIPTION OF *PLATISTUS* AND ITS
ONLY INCLUDED SPECIES, *P. SPINICEPS*
(HETEROPTERA: PENTATOMIDAE)**

D. A. RIDER

Department of Entomology, North Dakota State University,
Fargo, North Dakota 58105

Abstract.—Evidence is given to support the discovery of type material for *Aelia spiniceps* Herrich-Schäffer, 1840 and *Pentatoma scabricorne* Herrich-Schäffer, 1844. A lectotype designation is made for *Aelia spiniceps*. *Platistus* and *P. spiniceps* are redescribed.

Pentatomids sent by the Museum für Naturkunde der Humboldt-Universität zu Berlin for identification included a very distinctive specimen that exactly matches the description and figures of *Aelia spiniceps* Herrich-Schäffer, 1840. Since the label data also match that given in the original description, this specimen appears to be the type specimen for the species. In 1853, Herrich-Schäffer proposed *Platistus* as a new genus name to house the single species, *A. spiniceps*. Inasmuch as the original description of *Platistus spiniceps* is meager, and so far only the type specimen is known, the genus and species are redescribed herein. The only literature records are the original description and several references citing the original description.

Another specimen in this lot of pentatomids matches the description and figure for *Pentatoma scabricorne* Herrich-Schäffer, 1844, and once again the label data match that given in the original description. This specimen is surely the type specimen for *P. scabricorne*. Known now as *Agroecus scabricornis*, this species has been diagnosed in a recent generic revision (Rider and Rolston, 1987).

Where label data are presented in the text, each letter in parentheses represents a separate label with (a) being closest to the specimen. Type label data are quoted exactly as they appear on the label.

Platistus Herrich-Schäffer, 1853

Platistus Herrich-Schäffer, 1853:167 (not described); Stål, 1872:65 (not described); Kirkaldy, 1909:238.

Description. Jugal longer than tylus and contiguous anteriorly, produced into spines distally, each with prominent anteocular spine. Antennal segment I distinctly surpassing apex of head. Bucculae relatively short, lobately produced anteroventrad, curving medially and meeting posteriorly. Beak relatively short, reaching only to mesocoxae, first segment reaching only slightly beyond posterior margins of bucculae.

Anterolateral margins of pronotum carinate, becoming slightly crenulate anteriorly; humeral angle somewhat prominent. Scutellum much longer than wide; scutellar

tongue very long and narrow. Prosternum and mesosternum narrow, flat to broadly tumid, mesosternum slightly elevated medially at anterior and posterior margins [metasternum destroyed by pin in unique specimen]. Ostiolar rugae long, acuminate apically, each reaching two-thirds distance from mesial margin of ostiole to lateral metapleural margin. Tarsi 3-segmented. Base of abdomen apparently roundly tumid [also damaged in unique specimen].

Posterolateral angles of genital capsule horn-like, produced posteriorly; genital capsule broadly and roundly excavated in ventral view. Parameres very small, reduced; proctiger prominent, produced caudad and then angled ventrad, angled area somewhat bulbous. Female unknown.

Comments. The tribal and subfamilial affinities of this genus are difficult to discern. The exposed spiracles on the second abdominal segment are characteristic of the Tessaratomidae, but the male genitalia are unlike that of any tessaratomid I have examined. The shape of the bucculae is similar to that found in the Tessaratomidae, Dinidoridae, Edessinae, and several genera placed in section 3 of the Pentatominae (*sensu* Rolston, McDonald and Thomas, 1980). *Platistus* is tentatively placed in the Pentatomini near *Tibilis* Stål, *Lopadusa* Stål, and *Brachystethus* Laporte, but all of these genera may actually be more closely related to the edessines than previously thought.

Herrich-Schäffer did not formally describe the genus name *Platistus* in his 1853 publication. This publication is, however, an index to all of the previous volumes of the Wanzenartigen Insecten, which is the publication in which the original description of *A. spiniceps* first appeared. So, the original use of the genus name, *Platistus*, was in an index which refers back to a valid species description in the same publication. According to the rules of zoological nomenclature this should serve as an "indication" sufficient to validate the genus name. Stål (1872) also referred to the genus and species name, but did not provide descriptions of either. Kirkaldy (1909) first published a description of the genus name, but apparently based this description on Herrich-Schäffer's original species description and illustrations.

Platistus spiniceps (Herrich-Schäffer, 1840)

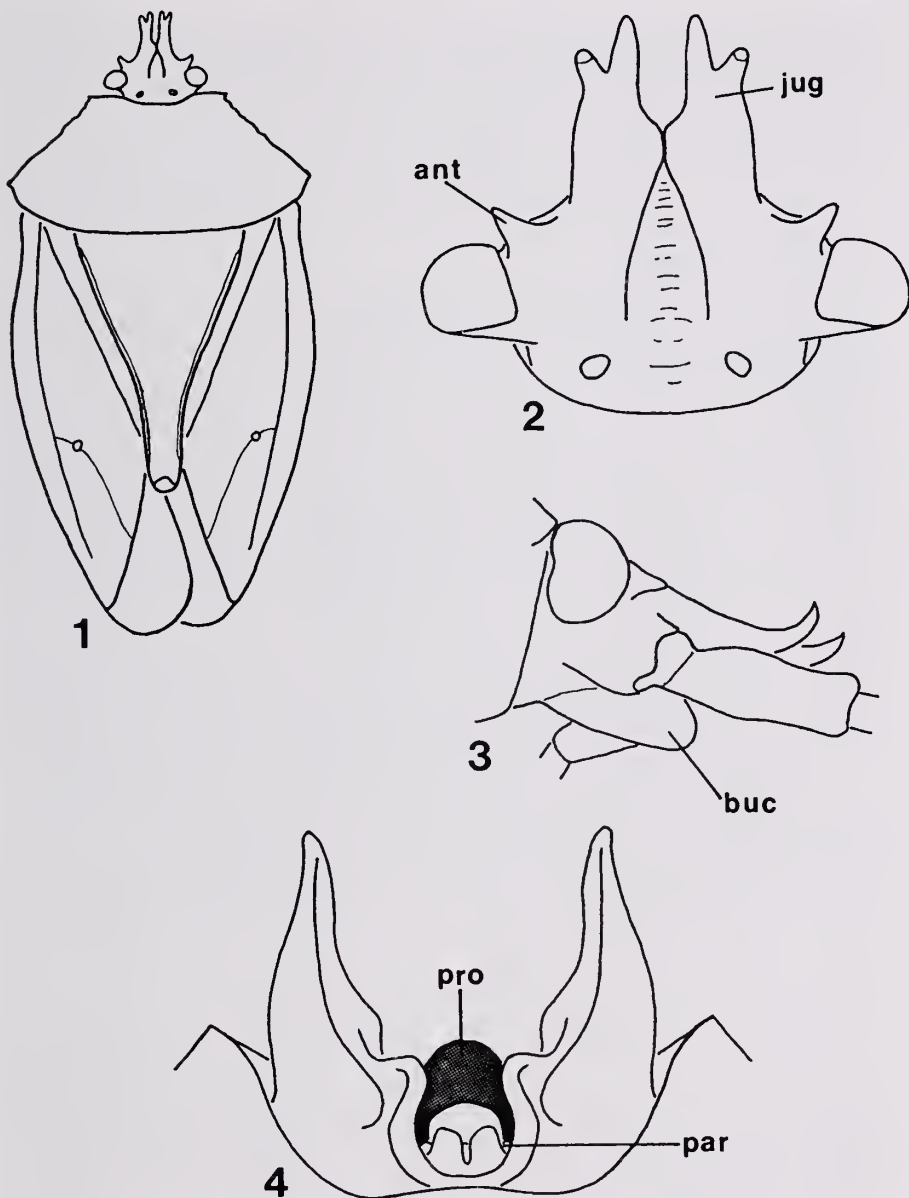
Figs. 1–4

Aelia spiniceps Herrich-Schäffer, 1840:72, figs. 517A–E.

Platistus spiniceps: Herrich-Schäffer, 1853:167, Stål, 1872:65; Kirkaldy, 1909:238.

Description. Medium-sized, somewhat elongate oval, depressed and flattened above. Overall color pale yellow (may have been green when alive); punctures concolorous.

Head relatively flat above, especially vertex. Jugal sulcus much longer than and meeting in front of tylus; each divided apically into two strong, dorsad-curving spines, leaving deep U-shaped sinus in front of head; lateral margin of each jugum armed with stout denticle just anterior to each eye (Fig. 2, ant). Tylus relatively broad basally. Compound eyes appearing slightly stalked; ocelli remote, distance from each ocellus to adjacent eye 3–4 times diameter of ocellus. Antenniferous tubercles clearly visible from above; antennal segment I pale yellow, reaching beyond apex of head; antennal segments II–III pale green (segments IV–V missing), segment II one-third longer than III; segment II with numerous relatively stout, short bristles; segment III with shorter, more appressed hairs.



Figs. 1–4. *Platistus spiniceps*. 1. Habitus. 2. Head, dorsal view. 3. Head, lateral view. 4. Pygophore, ventral view. Symbols: ant, anteocular process; buc, buccula; jug, juga; par, paramere; pro, proctiger.

Anterior pronotal disc large and relatively flattened; posterior disc narrow, curving ventrad rather abruptly to level of scutellum, paler than anterior disc. Punctures on pronotum relatively sparse, becoming more dense cephalad and laterad of cicatrices, forming distinct, diagonal, rugose lines along anterolateral margins. Anterolateral pronotal margins nearly straight, slightly crenulate towards head; anterior margin arcuately concave behind head; humeral angles prominent, rectilinear, posterolateral margins slightly concave, giving humeral angles slight hooked appearance; posterior margin broadly and shallowly convex; a small, obtuse, submarginal tubercle located near each humeral angle.

Scutellum rather sharply triangular, much longer than wide; scutellar tongue very long and narrow, reaching slightly beyond inner distal angles of coria. Narrow lateral margins much paler than scutellar disc, apex with small ivory spot; punctures rather small and sparse, concolorous; a few pale brown, forming weak transverse lines on scutellar disc; vague longitudinal raised line running from scutellar base onto base of scutellar tongue. Hemelytra with leathery portion large, membrane reduced; basal costal margins of coria narrowly pale, apex of each reaching beyond posterolateral angle of last connexival segment. Surface of each corium and clavus with matte or shagreened texture, punctures relatively small and sparse; wing membrane hyaline with numerous irregular wrinkles, veins indistinct. Each corium with small, pale, discal spot and thin, pale, venule running from R+M vein through discal spot to posterior corial margin. Posterior margin of corium nearly straight. Connexiva immaculate.

Ventral surface of head yellow; lacking punctures except for few weak punctures on bucculae; antenniferous tubercles large, appearing inflated. Bucculae short, lobately produced anteroventrad (Fig. 3), posterior margins curving and meeting medially behind beak. Rostrum short, segment I reaching only slightly beyond posterior margins of bucculae, segment II as long as segments III and IV together, segment IV shortest, apex dark brown, reaching to anterior margins of mesocoxae.

Thoracic pleura sparsely punctate except around coxae, near humeral angles, and posterior to evaporative area more punctate. Prosternum relatively flat, very narrow, somewhat depressed between procoxae; mesosternum broadly transversely tumid, midline orange-brown, slightly raised anteriorly and posteriorly, mesocoxae also narrowly spaced. [Insect pin has obliterated all characters of the metasternum and the base of the abdomen.] Ostiole relatively large and transversely elongate; ostiolar rugae long, acuminate apically, reaching two-thirds distance from mesial margin ostiole to lateral metapleural margin. Legs pale yellow, tarsi and apices of tibiae pale greenish. Base of third (second visible) abdominal segment damaged by pin, but appearing to be bluntly produced. Abdominal segments III–IV curving cephalad medially; posterior margin of segment VII convexly produced posteriorly, medial length greater than length of segments V and VI taken together. Spiracles pale.

Posterolateral angles of pygophore hornlike, strongly produced posterodorsad; from ventral view pygophore deeply and broadly excavated; excavation rounded with margins distinctly reflexed ventrally, within excavation two flattened, apically truncate projections located one on each side of middle; proctiger bulbous, distinctly and obtusely produced caudad, then oriented ventrad, clearly visible from ventral view (Fig. 4). Parameres very small, situated near ventrolateral margins of proctiger. Female unknown.

Measurements. Total length 9.76; maximum width 5.02; medial length of pronotum 2.21. Medial length of scutellum 4.43; basal width 2.96; width at distal end of frena 0.84; medial length from distal end of frena to apex 1.54. Length of head from apex to imaginary line drawn through posterior margins of ocelli 1.46; width 1.97; intraocular width 1.26; intraocellar width 0.51; ocellar diameter 0.11; distance from ocellus to adjacent eye 0.32. Length of segments I-III of antennae 0.75, 3.15, and 2.26 respectively. Length of segments II-IV of rostrum 1.11, 0.59, and 0.38, respectively.

Type. Although it is generally accepted that most type specimens of Herrich-Schäffer's species were destroyed during the first and second World Wars, I am convinced that this is the specimen Herrich-Schäffer used to describe *Aelia spiniceps*. In his original description he states that this species is "Aus Brasilien; von Herrn Germar." Both Brasil and Coll. Germar appear on the label accompanying this specimen. The species is very distinct, and as far as I know this is the only known specimen of the species.

Herrich-Schäffer (1840) did not state how many specimens he had to make his description, so this single specimen must be considered a syntype. It is here designated lectotype and has the following label data: a) "8007" b) "spiniceps Herr. Schffr. Brasil. Coll. Germ." and c) "Z.M.B. Hem."

The type specimen is in remarkably good condition considering its history. It is missing all but segment I of the left antenna and all but segments I-III of the right antenna. All three left legs and the right front leg are in good condition, but the right middle and hind legs have only the coxae present. The left wing is slightly ajar and the right wing has broken loose, but has been reglued close to its original position. As mentioned above, the specimen has been pinned twice, resulting in the destruction of the characters of the metasternum and the base of the abdomen.

Comments. Both the jugs and the genitalia of this species are distinctive.

Perhaps this description and figures will help locate more specimens in various museums. The proper placement of this species will undoubtedly depend on the dissection and examination of the genitalia of both male and female specimens. Since some of Herrich-Schäffer's type specimens that were presumed lost have been found, additional unrecognized type material may still exist in other collections.

Agroecus scabricornis (Herrich-Schäffer, 1844)

Pentatoma scabricorne Herrich-Schäffer, 1844:98-99, fig. 762; Stål, 1872:65.

Euschistus scabricornis: Stål, 1860:19; Walker, 1867:248.

Lycipta scabricornis: Stål, 1862:58.

Agroecus scabricornis: Lethierry & Severin, 1893:126; Kirkaldy, 1909:63; Jensen-Haarup, 1937:171; Buckup, 1957:9, 15-16, pl. 1 fig. 4, pl. 2 fig. 4; Buckup, 1961:9; Rolston, 1982:281; Rider & Rolston, 1987:429, 434, 436, figs. 7, 10, 15, 22, 28, 32.

The genus *Agroecus* has been revised recently (Rider and Rolston, 1987) including a diagnosis and figures of *A. scabricornis* (Herrich-Schäffer). A redescription is not included here. This species can be recognized by the clearly defined, impunctate, transhumeral fascia and by the widely spaced pronotal denticles. This species is known only from southeastern Brazil.

Type. Herrich-Schäffer (1844) stated that he described this species from one female specimen from Brazil. He also stated that the specimen was from Germar's collection. Once again, I am convinced that this is the specimen that Herrich-Schäffer used to produce his description of *Pentatoma scabricorne*. It is a female specimen with the following label data: a) "7983" b) "scabricornis Herr. Schffr. Brasil. Coll. Germ." c) "Z.M.B. Hem." Herrich-Schäffer stated that he had just one female specimen; therefore this specimen is recognized as the holotype and a label has been added to designate this status.

The holotype is in remarkably good condition. Both antennae are complete; all three right legs and the left hind leg are complete, while the left front leg is missing the last two tarsal segments and the left middle leg is missing all tarsal segments. The rest of the specimen is in good condition.

Comments. This is a fairly distinctive species in the genus and has been correctly identified in all recent publications.

ACKNOWLEDGMENTS

I am indebted to Dr. Jürgen Deckert, Museum für Naturkunde der Humboldt-Universität zu Berlin, for the loan of this material and for allowing me to study these specimens. I would also like to thank Dr. L. H. Rolston, Louisiana State University, and Dr. Jayma A. Moore, Fargo, North Dakota, for their encouragement and reviews of an early draft of the manuscript.

LITERATURE CITED

- Buckup, L. 1957. Pentatomídeos Neotropicalis—I. Sobre o gênero *Agroecus* Dallas, 1851 com a descrição de duas espécies novas (Hem.-Pentatomidae). Iheringia, Zoologia 6:1–20, 2 pls.
- Buckup, L. 1961. Os Pentatomídeos do Estado do Rio Grande do Sul (Brasil) (Hemiptera-Heteroptera-Pentatomidae). Iheringia, Zoologia 16:1–24.
- Herrich-Schäffer, G. A. W. 1840. Die Wanzenartigen Insecten. Nürnberg 5:61–108.
- Herrich-Schäffer, G. A. W. 1844. Die Wanzenartigen Insecten. Nürnberg 7:41–134.
- Herrich-Schäffer, G. A. W. 1853. Die Wanzenartigen Insecten. Nürnberg, Index:1–210.
- Jensen-Haarup, A. C. 1937. Einige neue Pentatomidenarten aus der Sammlung des Zoologischen Museums in Hamburg (Hem. Het.) Entomol. Rundschau 54:169–171, 321–324.
- Kirkaldy, G. W. 1909. Catalogue of the Hemiptera (Heteroptera) with Biological and Anatomical References, Lists of Foodplants and Parasites, etc. Vol. I: Cimicidae. Felix L. Dames, Berlin, 1:i–xl, 1–392.
- Lethierry, L. F. and G. Severin. 1893. Catalogue Général des Hémiptères. Tome I. Hétéroptères. Pentatomides. F. Hayez, Bruxelles, 1:i–x, 1–286.
- Rider, D. A. and L. H. Rolston. 1987. Review of the genus *Agroecus* Dallas, with the description of a new species (Hemiptera: Pentatomidae). J. New York Entomol. Soc. 95(3): 428–439.
- Rolston, L. H. 1982. A revision of *Euschistus* Dallas subgenus *Lycipta* Stål (Hemiptera: Pentatomidae). Proc. Entomol. Soc. Wash. 84(2):281–296.
- Rolston, L. H., F. J. D. McDonald and D. B. Thomas, Jr. 1980. A conspectus of Pentatomini genera of the Western Hemisphere. Part 1 (Hemiptera: Pentatomidae). J. New York Entomol. Soc. 88:120–132.
- Stål, C. 1860. Bidrag till Rio Janeiro-traktens Hemipter-fauna. Kongliga Svenska Vetenskaps-Akademiens Handlingar 2(7):1–84.
- Stål, C. 1862. Bidrag till Rio Janeiro-traktens Hemipter-fauna. Kongliga Svenska Vetenskaps-Akademiens Handlingar 3(6):1–75.

- Stål, C. 1872. Enumeratio Hemipterorum. Bidrag till en förteckning öfver alla hittills kända Hemiptera, jemte systematiska meddelanden. Part 2. Enumeratio Cimicinarum Americae. Kongliga Svenska Vetenskaps-Akademiens Handlingar 10(4):3–65.
- Walker, F. 1867. Catalogue of the specimens of Heteropterous-Hemiptera in the collection of the British Museum. British Museum, London 1:1–240.

Received 11 May 1992; accepted 21 July 1992.

THE FIRST THRIPS SPECIES
(INSECTA) INHABITING LEAF DOMATIA:
DOMATIATHRIPS CUNNINGHAMII GEN. ET SP. NOV.
(THYSANOPTERA: PHLAEOTHIRIPIDAE)

LAURENCE A. MOUND

Entomology Department, The Natural History Museum,
London SW7 5BD, U.K.

Abstract.—A new genus and species of tubuliferan Thysanoptera is described, *Domatiathrips cunninghamii*, which seems to be related to a group of moss-feeding species. With an adult body length of scarcely 1 mm, all life stages of the thrips were found living solitarily inside leaf domatia of a Rubiaceae under-story rain-forest tree in Costa Rica. The literature on the significance of leaf domatia and their relationships to arthropods is discussed.

Domatia have been defined as plant-produced chambers that house animals, differing from galls in that they are not induced by their inhabitants. In giving this definition, O'Dowd and Willson (1991) recognized two principal types: ant domatia, usually in hollow stems, thorns and petioles; and mite domatia, on the under-side of leaves in the axils of primary and secondary veins. The occurrence of other organisms in these plant structures seems to be regarded as largely casual.

The purpose of this paper is to record the presence of all life stages, egg to adult, of a minute phlaeothripine Thysanopteran insect within the leaf domatia of a rain-forest understorey tree in Costa Rica. The presence of these insects, apparently obligatorily but with no obvious benefit to the plant, suggests a reconsideration of the views of Jacobs (1966), who questions the necessity for a single mutualistic explanation for leaf domatia.

The thrips species, which is described here as a new genus and species, is one of the smallest members of this insect order. It was first discovered by Saul Cunningham, of the University of Connecticut, within the leaf domatia of *Psychotria graciliflora* Bentham (Rubiaceae) at La Selva Research Station in Costa Rica. According to Dr. Orlando Vargas of La Selva, who kindly identified this tree, two similar species of *Psychotria* are known at this site, but only *graciliflora* has domatia on its leaves in contrast to *P. chagensis* Stand.

THE DOMATIA

Psychotria graciliflora is an understorey tree, with a curious growth habit such that the branches with their small leaves tend to form flat layers rather like an African *Acacia* tree. It shares this habit with certain other rainforest understorey trees, such as *Randia karstenii* Polakowsky (Rubiaceae). However, judging from herbarium material at The Natural History Museum, the growth habit, leaf size and development of domatia are variable in *P. graciliflora*, possibly in relation to the degree of shading by top canopy trees. The leaves collected at La Selva were small, 20 to 40 mm, and many had small epiphytes on the surface.

Domatia were not observed on the youngest or smallest leaves, but varied in number from one to three on those leaves on which they were present. Each domatium is situated at the junction of a secondary vein with the midrib, and extends basally from its pore along the side of the midrib, between this and a rather thickened, basally curved, lateral vein (Fig. 5). In the absence of a domatium, a secondary vein is not curved basally but joins the midrib at an obtuse angle, and so the development of a domatium must be determined early in the ontogenesis of a leaf. The form of these domatia is that of a "pocket" (Jacobs, 1966), in that they are completely enclosed with one terminal opening. The inner cavity is about 1.5 mm long, and narrows gradually from an almost spherical chamber 0.4 mm in diameter under the pore to a rounded apex about 0.1 mm in diameter.

A sample of twigs bearing about 200 leaves was taken from each of three *P. graciliflora* trees at La Selva; two were close together under the canopy of old *Theobroma cacao* L., the third was 20 meters away within primary forest. The tree was common at this site, and ranged in size up to about two meters. The leaves in each sample were examined using transmitted light, because the domatia are translucent and their contents can thus be observed easily. Nothing was found in the domatia of the leaves from the third tree, but the thrips listed below were equally distributed between the leaves of the other two trees. No mites were observed in these domatia, but they could have been overlooked.

THE THRIPS

Phlaeothripine Thysanoptera species deposit their eggs, one at a time, on the surface of their feeding substrate using a chute-like ovipositor (Mound and Heming, 1991). They have two feeding larval stages, and three non-feeding pupal stages before the adults emerge. Examples of each of these immature stages were found in the leaf domatia studied. Like many other phlaeothripines, the adults of this species are either winged or wingless, although it is possible that winged males are not developed.

Thrips were found in less than 10% of the leaves collected, and their distribution was evidently clustered. On some twigs the leaves had no thrips, but on a few twigs most leaves bore one or more thrips. A few leaves had one thrips in each domatium (egg, larva, pupa or adult), but no domatium had more than one inhabitant. Only one thrips was found outside of a domatium; this was a winged adult female which was found walking on the sample when this was removed from the collecting bag several hours later. The author usually collects thrips by beating plants over a plastic tray, the adhesive tarsal pad of these insects causing them to stick to the plastic surface (Palmer, Mound and DuHeaume, 1989). No thrips were taken when these trees were beaten, suggesting that each insect was inside a domatium at the time.

The eggs were found singly, laying transversely at the bottom of the domatia. The other instars were usually found head down in a domatium, although when disturbed an adult would back-up into the main cavity and then try to emerge head first through the pore.

These observations all suggest that this thrips species was not casual within the domatia. Due to their enclosed situation they could not be observed actually feeding on the leaf tissue and, curiously, the species appears to be related to a group of species normally found in association with mosses and lichens (Mound, 1989). Moreover,

a green pigment was pressed out of the gut of several adult specimens when they were being prepared onto microscope slides. Such a pigment has only been observed before when preparing moss-feeding thrips, never with the much more common leaf-feeding species on dicotyledonous plants. Thus the possibility cannot be excluded that the thrips may be feeding on epiphytic micro-organisms on the leaf surface.

The only thrips species known to live in a comparable situation is *Rhopalothripoides froggatti* (Bagnall) which breeds within the cavities of the leaf nectaries of certain pinnate-leaved *Acacia* trees in Australia. In *Acacia paramattensis* Tind. up to 20 eggs have been observed in one of these leaf glands, although usually no more than two adults have been found (Mound, 1971). However, crawling into small spaces is an essential aspect of thrips biology (Mound, 1993), and further examples of such cryptic associations may yet be found.

DISCUSSION

The evidence for mutualism between ants and plants is extensive and convincing. Hölldobler and Wilson (1990) tabulate the wide range of such relationships, and Huxley and Cutler (1991) discuss many ant-plant interactions in considerable detail. In contrast, the evidence for mutualisms between mites and plants is largely based on circumstantial evidence. O'Dowd and Willson (1989) analyze a wide range of mite domatia, but their evidence for the suggestion that leaf domatia are produced by plants in order to house mites lacks an experimental base.

The taxonomic distribution of leaf domatia amongst the flowering plants is reviewed by O'Dowd and Willson (1989). These structures occur in most of the major lineages, apart from the monocotyledons and the Caryophyllales. They are particularly common amongst the Rubiales of the Asteridae, the most advanced lineage of dicotyledons. These authors also tabulate the remarkably large number of families of mites, not all identified but probably 27, that they collected from the leaves of 36 plant species with leaf domatia in the Australasian region. Many species in these mite families are known to be fungivorous or predatory, and the high frequency with which such mites were found on the leaves of these plants is taken as evidence in favour of mutualism between mites and plants—the mites being assumed to keep away microfungi and phytophagous mites. O'Dowd and Willson (1991) point out that such a relationship could be tested experimentally. However, Jacobs' experiments (1966) demonstrated that domatia developed normally on several trees in the absence of mites, and he maintains that views on mutualism owe as much to wishful thinking as to careful observation.

The difficulty is that leaves, particularly in the tropics, provide an extensive and heavily exploited habitat for microorganisms (Hawksworth, 1991) as well as small arthropods such as mites and thrips. Moreover, mites, like thrips (Mound, 1993), have the habit of crawling into small spaces. It is true that leaf domatia seem to be more frequent on tropical than on temperate plants, and also that leaf epiphytes are more common in the tropics. But these correlations cannot be taken to demonstrate mutualism in anything other than a very broad sense. Small arthropods can be expected to make use of any cavities slightly larger than their body size simply as shelters in which to reduce water loss through respiration. O'Dowd and Willson (1989) summarize the various other suggestions which have been made concerning

the biological significance of leaf domatia, but the advantages to the plants remain obscure and undemonstrated. Certainly, the provision of pockets in which minute thrips can breed seems unlikely to benefit the plants, and the suggestion of mutualism with other organisms remains unproven.

Domatiathrips, new genus

Minute macropterous or micropterous Phlaeothripinae-Williamsiellina. Antennae 8-segmented, III with 2 sense cones, IV with 3 sense cones, VIII not narrowed at base. Head longer than wide; stylets relatively broad, very widely separated with a maxillary bridge, retracted to postocular setae. Pronotal epimeral sutures complete or incomplete; praepectal plates present, mesopraesternum broad; meso and metathoracic furcae not fused in micropterae, metathoracic sterno-pleural sutures not developed in either morph. Fore tarsus with inner apex recurved into a small tooth in both sexes. Forewings parallel sided, with few duplicated cilia. Pelta D-shaped; macropterae with two pairs of wing retaining setae on tergites II-VII. Major setae capitate, including B1 on tergite IX. Sternites II-VII with median pair of marginal setae not longer than the discal setae. Male without a glandular area on sternite VIII; setae B2 on tergite IX short and pointed.

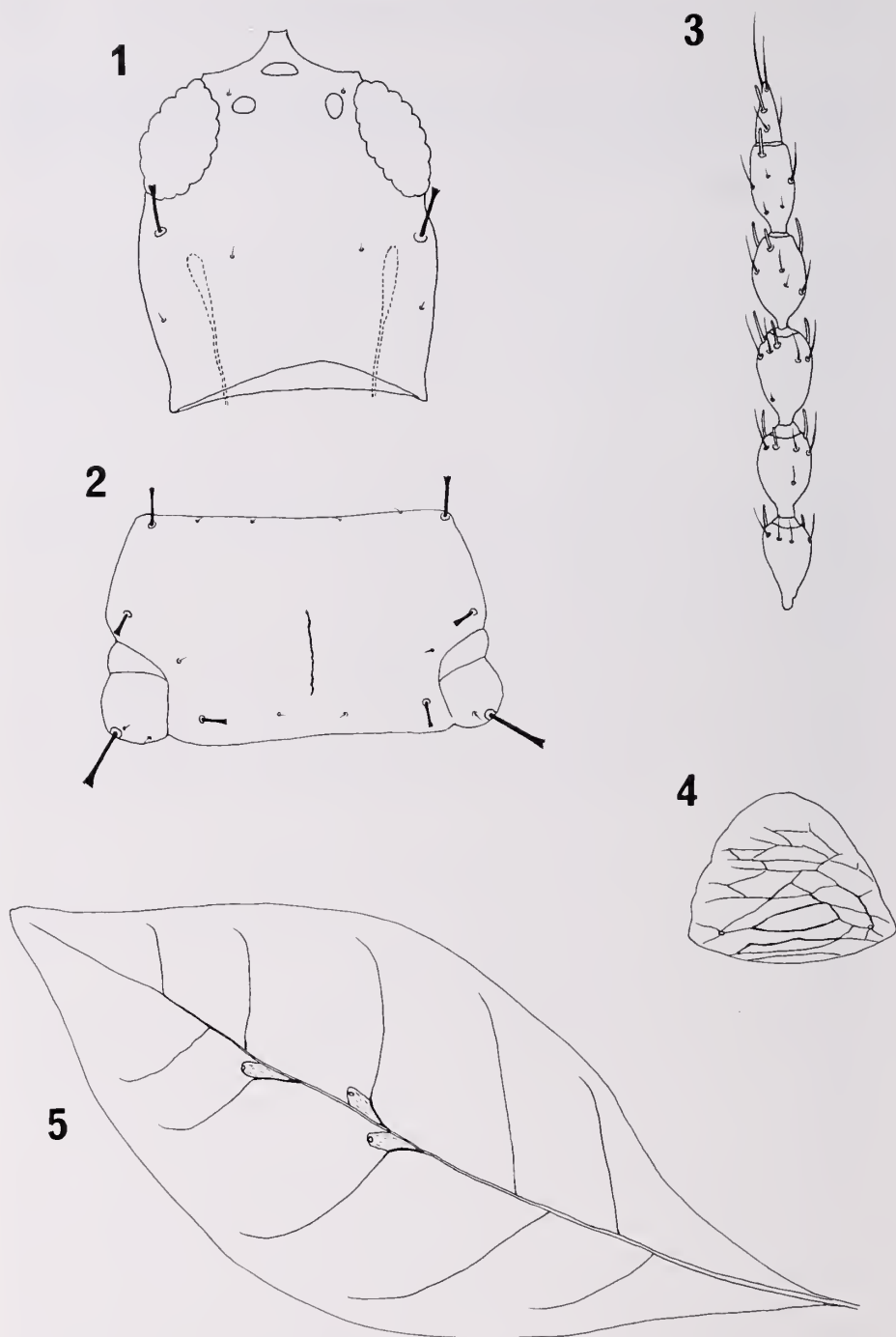
Type species *Domatiathrips cunninghamii*.

This new genus seems to be related to *Williamsiella* in the small size of the third antennal segment, and the relatively broad maxillary stylets. Unlike other members of the Williamsiellina the setae on tergite IX are shorter than the tube, and the median setae on the sternites are exceptionally short. The only species of *Williamsiella* with a similar long head is *longiceps* Hood, but that has seven-segmented antennae, the stylets restricted to the mouth cone, a transverse pelta, and a transverse glandular area on sternite VIII of the male.

Domatiathrips cunninghamii, new species

Female macroptera. Colour light brown; tarsi, apices of all femora, extreme base of tube, and antennal segments I-VI pale. Forewing pale with base and scale dark, and lightly shaded in basal half. Major setae dark.

Head (Fig. 1) with postocular setae wide apart; vertex without sculpture; mouth cone rounded. Antennae (Fig. 3) with segment V largest, 2 sense cones on III and 3 on IV-VI. Pronotum without sculpture, epimeral sutures almost complete, antero-marginal setae minute (Fig. 2). Mesonotal lateral setae minute; metanotum almost without sculpture, median setae small and acute. Fore tarsus with small hook on inner apical margin, much smaller than hamus. Forewing sub-basal setae reduced, 3 or 4 duplicated cilia present. Pelta D-shaped with distinct sculpture (Fig. 4); abdominal tergites with median area sculptured, wing retaining setae straight on tergite II but sigmoid on III-VII; the anterior pair of each wing retaining setae much smaller than the posterior pair on these tergites; tergite IX B1 setae short and capitate, B2 and B3 acute, shorter than tube; tube scarcely half as long as head, terminal setae shorter than tube. Sternites II-VII with 2 pairs of marginal setae and 3 pairs of discal setae; marginal setae on VIII much longer than on preceeding sternites. Measurements (Holotype ♀ macroptera in μm): Body length 1,200. Head, length 135; width 110; postocular setae 20. Pronotum, length 80; width 140; setal lengths—am 3, aa 15, ml



Figs. 1-5. 1-4. *Domatiathrips cunninghamii*—1, Head; 2, Pronotum; 3, Antennal segments III-VIII; 4, Pelta. 5. *Psychotria graciliflora* leaf, showing axillary domatia.

15, epim 25, pa 12. Metanotal median setae 12. Forewing, length 450; maximum width 40; sub-basal setae 5, 15, 15. Tergite IX setae—B1 30, B2 45, B3 50. Sternite VII marginal setae B1 10. Tube, length 75; terminal setae 60. Antennal segments length—I 18, II 33, III 28, IV 30, V 33, VI 33, VII 33, VIII 25.

Female microptera. Very similar to macroptera in colour and structure except—ocelli scarcely developed; forewing 40 μm long without setae, tergal wing retaining setae short and straight on II, posterior pair on III–VI also short.

Male microptera. Very similar to female except—smaller, with tergal wing retaining setae even more reduced, and a slightly larger fore tarsal tooth; tergite IX B2 setae short, sternite VIII without a glandular area; pseudovirga well developed and parallel sided. Measurements (paratype δ in μm): Body length 1,050. Head, length 130; width 100; postocular setae 25. Pronotum, length 85; width 135. Tergite IX setae—B1 30, B2 25, B3 50. Tube length 80.

Immature stages. Egg: About 400 μm long; surface of chorion with typical hexagonal plates; the apex of three slide-mounted eggs with a curious dome-shaped swelling which appears to break through the chorion. Larvae: Major setae capitate as in adult, tube with one pair of exceptionally long setae; first instar pale with red hypodermal pigment in pro- and metathorax; second instar with pronotum and tube brown; pupae pale with scattered red pigment spots.

Material studied. Holotype female macroptera: Costa Rica, La Selva Biological Research Station, Porto Viejo, Sarapiquí, on *Psychotria graciliflora* leaves, 27 April 1992 (L. A. Mound 2307), in BMNH. Paratypes: 6 female micropterae, 6 male micropterae, removed from leaf domatia of the same sample of *Psychotria graciliflora* from which the holotype was collected.

LITERATURE CITED

- Hawksworth, D. L. 1991. The fungal dimension of biodiversity: magnitude, significance and conservation. *Mycological Research* 95:641–655.
- Hölldobler, B. and E. O. Wilson. 1990. *The Ants*. Belknap Press of Harvard University, Cambridge, 732 pp.
- Huxley, C. R. and D. F. Cutler (editors). 1991. *Ant-Plant Interactions*. Oxford Science Publications, Oxford, 601 pp.
- Jacobs, M. 1966. On domatia—the viewpoints and some facts. *Proceedings. Koninklijke Nederlandse Akademie van Wetenschappen, Series C* 69:275–316.
- Mound, L. A. 1971. Gall-forming thrips and allied species (Thysanoptera: Phlaeothripinae) from *Acacia* trees in Australia. *Bulletin of the British Museum (Natural History) Entomology* 25:387–466.
- Mound, L. A. 1989. Systematics of thrips (Insecta: Thysanoptera) associated with mosses. *Zoological Journal of the Linnean Society* 96:1–17.
- Mound, L. A. 1993. Thrips and plant-gall induction: a search for patterns. *Systematics Association* (in press).
- Mound, L. A. and B. R. Heming. 1991. Thysanoptera. Chapter 31. Pages 510–515 in: CSIRO. *The Insects of Australia*. Melbourne University Press, Melbourne.
- O'Dowd, D. J. and M. F. Willson. 1989. Leaf domatia and mites on Australasian plants: ecological and evolutionary implications. *Biological Journal of the Linnean Society* 37: 191–256.
- O'Dowd, D. J. and M. F. Willson. 1991. Associations between mites and leaf domatia. *Trends in Evolution and Ecology* 6:179–182.

Palmer, J. M., L. A. Mound and G. J. du Heaume. 1989. Guides to Insects of Importance to Man. 2. Thysanoptera. Edited by C. R. Betts. CAB International Institute of Entomology and British Museum (Natural History), London. 73 pp.

Received 29 July 1992; accepted 17 September 1992.

NOTES AND COMMENTS

J. New York Entomol. Soc. 101(3):431–433, 1993

OVERLOOKED NAMES IN NEPOMORPHA, NEW SYNONYMY, AND A NEW NAME (HETEROPTERA: CORIXIDAE, NOTONECTIDAE)

In the preparation of a catalog of the aquatic and semiaquatic Heteroptera of the world, I have found two species of Nepomorpha, *Notonecta minutior* Sulzer 1776 and *Notonecta marginata* Müller 1776, that have escaped the notice of recent authors although Reuter (1888) dealt with both of them, and as late as 1933 Hungerford dealt with *marginata*. The synonymies are given below, and a necessary new name is provided for *Notonecta minuta* Hungerford 1926, a junior synonym of *Notonecta minuta* Gmelin 1790, the latter an emendation of *Notonecta minutior* Sulzer 1776.

Notonecta minutior Sulzer

Notonecta minutior Sulzer, 1776:91.

Notonecta minutior, Goeze, 1778:169.

Notonecta minuta Gallén, 1787:61 (list only; no author or description; nomen nudum).

Notonecta minutior, Roemer, 1789:78.

Notonecta minuta Gmelin, 1790:2119 (emendation).

Sigara minutior, Schrank, 1801:60, 1079.

Notonecta minuta, Turton, 1802:605.

Corisa sp. Reuter, 1888:377.

This was the species figured by Roesel as *Corisa* sp. (1755, vol. III, p. 159, tab. 29, fig. d) according to Schrank (1801, who erroneously gave the page number as 179). Jansson (1986) did not treat *minutior* in his exhaustive work on Palearctic Corixidae, however he was aware of the name and has now determined that it is most likely synonymous with *Sigara nigrolineata nigrolineata* (Fieber) (pers. comm.). Jansson and Polhemus have submitted a petition to the ICZN for the suppression of both *Notonecta minutior* Sulzer 1776 and *Notonecta minuta* Gmelin 1790 (for the purpose of priority but not homonymy) and placement of *Corisa nigrolineata* Fieber on the Official List of Specific Names in Zoology.

According to the 1985 code of the ICZN, all of the names given in the synonymy above are available, therefore *Notonecta minuta* Hungerford 1926 is a junior primary homonym and must have a new name as given below.

Whether or not the name *Notonecta minuta* Gmelin 1790, now shown to belong in the genus *Sigara*, is suppressed, any potential synonymical problem with regard to *Sigara minuta* Fabricius 1794 was eliminated by the suppression of the latter name by the ICZN (1988).

Notonecta marginata Müller

Notonecta marginata Müller, 1776:104 (no. 1177).

Notonecta marginata, Gmelin, 1790:2119 (no. 12).

Notonecta marginata, Turton, 1801:606.

Notonecta marginata, Reuter, 1888:282 (= *Sigara coleoptrata* Fabricius ?).

Notonecta marginata, Kirkaldy, 1897:420 (as var. of *N. glauca* L.).

Notonecta marginata, Oshanin, 1910:975 (= *Notonecta furcata* Fabricius, as var. of *N. glauca* L.).

Notonecta marginata, Oshanin, 1912:91 (?= *Notonecta glauca* L.).

Notonecta marginata, Esaki, 1928:69 (as var. of *N. glauca* L., following Kirkaldy 1897, but places species in Corixidae in note 15, p. 75).

Notonecta marginata, Hungerford, 1934:53 (places in Corixidae, following Esaki).

Jansson (1986) did not mention this species in his work on Palearctic Corixidae, as it has not been clear whether the species belongs in Notonectidae or Corixidae. Jansson (pers. comm.) has reanalyzed the original description and the *Notonecta* and Corixidae of Denmark and concluded that *Notonecta marginata* Müller 1776 and *Notonecta obliqua* Gallén 1787 are synonymous; a discussion is included in a petition by Jansson and Polhemus to the ICZN for the suppression of *N. marginata* Müller and conservation of *N. obliqua* Gallén.

N. marginata Müller was said by Esaki (1928), followed by Hungerford (1934:53), to belong in the Corixidae, however, it seems likely that he misinterpreted the original description. Esaki stated that the species description did not agree with any northern European notonectid species known to him, but matched all of the common corixid forms of Denmark; he also noted that Schiödte (MS notes in Schiödte's copy of Müller 1776 now owned by the British Museum) placed the species as a synonym of *Corixa hellensi* Fallén, a notion rejected by Jansson (pers. comm.).

Notonecta hungerfordi, New Name

Notonecta hungerfordi Polhemus, **NEW NAME**.

Notonecta minuta Hungerford, 1926:14 (primary homonym of *Notonecta minuta* Gmelin 1790).

Notonecta minuta, Hungerford, 1934:138.

Notonecta minuta, Stys & Riha, 1975:167.

Because this rare species has been cited only three times in the literature including the original description, a case cannot be supported for suppression by the ICZN of the name *Notonecta minuta* Gmelin 1790 to preserve *Notonecta minuta* Hungerford 1926. I therefore propose the replacement name *Notonecta hungerfordi* Polhemus. — J. T. Polhemus, University of Colorado Museum, 3115 S. York, Englewood, Colorado 80110.

ACKNOWLEDGMENT

I am indebted to Antti Jansson for sharing unpublished findings and critically reviewing the manuscript.

LITERATURE CITED

- Esaki, T. 1928. European species of *Notonecta*. Ann. Mag. Nat. Hist. (10) 2:65–76.
- Gallén, O. 1787. D. D. Museum naturalium Academiae Upsaliensis. Dissert. Part V. Donation Thunbergianae 1785, Continuat. III, pp. 59–68.
- Gmelin, J. F. 1790. Caroli a Linné, Systema Naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Georg Emanuel Beer, Lipsiae, Tomus 1, Pars IV, pp. 1517–2224.
- Goeze, J. A. E. 1778. Entomologische Beyträge zu des Ritter Linné zwölften ausgabe des Natursystems. Weidmanns Erben und Reich, Leipzig, Vol. 2, lxxii + 352 pp.
- Hungerford, H. B. 1926. Some *Notonecta* from South America. Psyche 33:11–16.
- Hungerford, H. B. 1934. The genus *Notonecta* of the world. Univ. Kansas Sci. Bull. 21[1933]: 5–195.
- International Commission on Zoological Nomenclature. 1988. Opinion 1491. *Micronecta griseola* Horváth, 1899 (Insecta, Heteroptera): specific name conserved. Bull. Zool. Nom. 45:165–166.
- Jansson, A. and J. T. Polhemus. In press. *Corisa nigrolineata* Fieber, 1848 [currently *Sigara (Pseudovermicorixa) nigrolineata nigrolineata*] (Insecta, Heteroptera): proposed conservation of the specific name. Bull. Zool. Nom.
- Jansson, A. 1986. The Corixidae (Heteroptera) of Europe and some adjacent regions. Acta Entomol. Fennica 47:1–94.
- Jansson, A. and J. T. Polhemus. In press. *Notonecta obliqua* Gallén, 1787 (Insecta, Heteroptera): proposed conservation of the specific name. Bull. Zool. Nom.
- Kirkaldy, G. W. 1897. Revision of Notonectidae I. Introduction and systematic review of the genus *Notonecta*. Trans. Entomol. Soc. Lond. 1897:393–426.
- Müller, O. F. 1776. Zoologiae Danicae prodromus, seu animalium Daniae et Norvegiae indiginarum characteres, nomina, et synonyma imprimis popularium. Hallageriis, Havniae, xxxii + 282 pp.
- Oshanin, B. 1910. Verzeichnis der Palearctischen Hemipteren mit besonderer Berücksichtigung ihrer Verteilung im russischen Reiche. Vol. 1, Heteroptera, Part 3, pp. 587–1087. Ann. Mus. Zool. St. Petersbourg, Vol. XIV, 1909.
- Oshanin, B. 1912. Katalog der Paläarktischen Hemipteren (Heteroptera, Homoptera-Auchenorrhyncha und Psylloidea). R. Freidlander & Sohn, Berlin, 187 + 1 (addenda and corrigenda) pp.
- Reuter, O. M. 1888. Synonymische Revision der von den Älteren Autoren (Linné 1758–Latreille 1806) Beschriebenen Palaearktischen Heteropteren. Druck. Finnischen Literatur-Gesellschaft, Helsingfors, I & II, pp. 1–458.
- Roemer, J. J. 1789. Genera insectorum Linnaei et Fabricii iconibus illustrata. Henric. Steiner, Vitoduri Helvetorum, 86 pp., 37 col. pls.
- Roesel von Rosenhof, A. J. 1775. Der monatlich herausgegebenen Insecten-Belustigung dritter Theil. . . . Nürnberg, 8 + 624 + 8 (Register) pp., 101 col. pls.
- Schrank, F. de P. 1801. Fauna Boica. Ingolstadt, Nürnberg, Band 2, Tiel 1, viii + 374 pp.
- Sulzer, J. H. 1776. Abgekürzte Geschichte der Insecten nach dam Linneischen System. H. Steiner u. Co., Winterhur, Teile 1, 27 + 274 pp.
- Stys, P. and P. Riha. 1975. Studies on Tertiary Notonectidae from central Europe (Heteroptera). Acta Univ. Carol.-Biologica 1973:163–184.
- Turton, W. 1802. A general system of nature through the three grand kingdoms of animals, vegetables and minerals. . . . Translated from Gmelin's last edition of the celebrated Systema Naturae. . . . Lackington, Allen & Co., London, Vol. II, 717 + 2 (errata) pp.

SYNONYMY OF *CURICTA HOWARDI* MONTANDON WITH *CURICTA SCORPIO* STÅL (HETEROPTERA: NEPIDAE)

The following synonymy of *Curicta howardi* Montandon with *C. scorio* Stål is abstracted from a systematic review of *Curicta* (Heteroptera: Nepidae) (Keffer, Ph.D. dissertation, 1991) that is currently being prepared for publication. A forthcoming review of the waterscorpion fauna of North America by Robert Sites and J. T. Polhemus requires the publication of the synonymy at this time.

Curicta scorio Stål

Curicta scorio Stål, 1862, Öfv. K. Svensk. Vet. Akad. Forh., 18(4):203. (1861).
Nepoidea montandoni Martin, 1898, Bull. Soc. ent. Fr., 4:68. Syn. by Champion, 1901:353.

Curicta howardi Montandon, 1910, Bull. Soc. rom Sti., 18(5,6):181-183, (1909).
NEW SYNONYMY.

Curicta drakei Hungerford, 1922, Kans. Univ. Sci. Bul., 14(18):432-433. Syn. by Kuitert, 1949, J. Kans. Entomol. Soc., 22(2):68.

In Montandon's original description of *C. howardi*, he offered five contrasting characters for *C. scorio* and *C. howardi* which can be summarized as follows (Montandon, 1910:183):

Character	<i>C. scorio</i>	<i>C. howardi</i>
1. Size	smaller	larger
2. Carina on vertex	no	yes
3. Scutellum carinate	no	yes
4. Pronotal sulci	shallower	deeper
5. Protibiae	dark at base only	darker throughout

The type for *C. scorio* measures 20.3 mm and the type for *C. howardi*, 19.5 mm so it is not clear why Montandon claimed a larger size for *C. howardi*. The protibial character is not diagnostic. All of the four types associated with this species have protibiae that are dark basally with a dark annulation somewhere in the proximal half. Further, protibial coloration is variable in previously identified *C. howardi* and *C. scorio* (301 non-type specimens were studied) and therefore does not follow the Montandon diagnosis. The other three characters, relating to carinae and sulci, are difficult to evaluate using the *C. scorio* type because much of the type's dorsum, including the head, pronotum, and scutellum, has been abraded or chemically treated, thus removing all the covering hair which contributes to sulci depth and carinae prominence. However, the raised cuticular patterns evident on this type indicate that a carina on the vertex and a raised, or carinate, trident pattern on the scutellum are both present. Further, I can see little difference between the pronotal sulci of the *C. howardi* and *C. scorio* types. There is variation in the depth of the median pronotal sulcus for non-type specimens in this species from deep to moderately deep, but the

variation is continual, found throughout the species' geographic range, and well within the range of variability found in this trait in other species of the genus (Keffler, 1991).

Only one character, the shape of the prosternum in lateral view, presents any difficulty concerning the synonymy of *C. howardi* with *scorpio*. In other species of *Curicta* the prosternum is either swollen in the distal half or not. However, in *C. scorpio* this character is not invariant but exhibits a continuum of form from swollen to declivent without swelling. The difficulty here is that there is some geographical clustering of these two extremes. South of Mexico all specimens examined have the swollen form. In Texas and Louisiana, the prosternum runs from subdeclivent with little posterior swelling to moderately swollen, with the former condition predominating. In Mexico both forms are present with much intermediacy. The types for *C. scorpio* (somewhere in Mexico) and *C. howardi* (Texas) have the swollen form (*C. howardi* less so than *C. scorpio*); the types for *N. montandoni* (Mexico) and *C. drakei* (Texas) are more declivent. I have tried in vain to use this character to delimit two or more species with these specimens. Because the variation is continuous it has been difficult to classify the prosternal shapes so that they might be mapped and studied for clinal variation. The best that can be said at this point is that the swollen form dominates in the south and the declivent in the north. (The absence of declivent forms south of Mexico may be an artifact of small sample size.) It could be that there are two species present in these specimens, corresponding to the two prosternal extremes, with a broad zone of sympatry between them in which hybridization has occurred. However, given that the specimens are equivalent in all other respects from Managua to New Orleans and that intermediate prosternal forms are pervasive and continuous, I have elected to synonymize *C. howardi* with *C. scorpio*.—S. L. Keffler, Department of Biology, James Madison University, Harrisonburg, Virginia 22801.

LITERATURE CITED

- Champion, G. C. 1897–1901. *Biologia Centrali-Americana*. Insecta. Rhynchota. Hemiptera-Heteroptera. Vol. 2. Taylor and Francis, London, xvi + 416 pp. [1897:1–32; 1898:33–192; 1899:193–304; 1900:305–344; 1901:i–xvi + 345–416].
- Hungerford, H. B. 1922. The Nepidae of North America (Further studies in aquatic Hemiptera). *Kans. Univ. Sci. Bull.*, 14(18):425–469.
- Keffler, S. L. 1991. Taxonomic revision and phylogenetic analysis of the genus *Curicta* (Heteroptera: Nepidae). Ph.D. dissertation, Southern Illinois University at Carbondale.
- Kuitert, L. C. 1949. Some new species of Nepidae (Hemiptera). *J. Kans. Entomol. Soc.* 22(2): 60–68.
- Martin, J. 1898. Descriptions d'espèces nouvelles de Nepidae. *Bull. Soc. ent. Fr.*, 23 Février: 66–68.
- Montandon, A. L. 1910. Hydrocorises de l'Amérique du nord. Notes et descriptions d'espèces nouvelles. *Bull. Soc. rom. Sti.* 18(5,6):180–191, (1909).
- Stål, C. 1861. Nova methodus familias quasdam Hemipterorum disponendi. *Öfv. K. Svensk. Vet.-Akad. Förh.* 18(4):195–212.

Received 19 January 1993; accepted 4 February 1993.

BOOK REVIEWS

J. New York Entomol. Soc. 101(3):436–437, 1993

Classification, Cladistics, and Natural History of Native North American *Harpalus* Latreille (Insecta: Coleoptera: Carabidae: Harpalini), excluding subgenera *Glanodes* and *Pseudophonus*.—Gerald R. Noonan. 1991. Thomas Say Foundation, Vol. 13. Entomological Society of America, 310 pp.

This revision is part of a revived Thomas Say monograph series intended for publication of taxonomic works by members of the Entomological Society of America. The book includes identification keys, descriptions and synonymies, a cladistic analysis, and a summary of phenology and habitat occurrence for 39 species of the genus *Harpalus* occurring in North America north of Mexico. *Harpalus* beetles live in drier habitats, such as grasslands, or open woodlands and forest clearings. Some species are geographically widespread, and exhibit variation in pubescence or color that has led to the extensive description of invalid species names. Examination of over 35,000 specimens permitted reassessment of species limits, description of two new species, and new synonymy of 49 invalid names, almost all described by Thomas Lincoln Casey. When it comes to revising groups previously touched by Col. Casey, the biodiversity crisis must be viewed with more than a few grains of salt.

The cladistic analysis was limited to the 39 northern North American species, with 44 palearctic species used as a taxonomic outgroup. This permitted character polarization and an assessment of phylogenetic relationships for 21 of the 39 native species from within the North American fauna. The other 18 taxa are probably more closely related to Old World taxa than to New World species.

This work exemplifies some major problems still to be worked out of the publication process by the Thomas Say series editors. Firstly, whereas the author included the results of fundamental taxonomic research in this volume, he removed a more substantive presentation of biogeographic research to a separate paper (Noonan, G. R., 1990, *J. Biogeogr.* 17:583–614). This leaves little of interest to non-carabidologists in this particular volume. E.S.A. authors should be encouraged to submit their best work to this series. Secondly, the publication is noteworthy for its marginal production values. Pages are small and the typeface large, requiring numerous page changes to use the identification keys. Figures are grouped at the back of the volume, are not consistently sized, nor arranged to fill the page. Tables are crudely composed and clumsily inserted into the text pages. Paper quality and type definition is marginal and poor respectively. If this is the face the Entomological Society wishes to put on its systematic publication series, they may find themselves hard pressed to attract future contributions. Or perhaps they wish to telegraph the message that for no page charges you will get poor production?

In summary, this revision establishes a sound taxonomy for the defined species of *Harpalus*, a necessary step before more substantive, and hopefully holarctically defined, cladistic and biogeographic studies are conducted. Unless you are a carabid ecologist or collector, you will not find much need for this book. You might best write the author and request a reprint of his biogeographic paper, and save your

money for subscription to a quality journal, such as this one.—*James K. Liebherr, Department of Entomology, Comstock Hall, Cornell University, Ithaca, New York 14853-0999.*

J. New York Entomol. Soc. 101(3):437–438, 1993

Systematics and Ecology of the Subgenus *Ixodiopsis* (Acari: Ixodidae: *Ixodes*).—Richard G. Robbins and James E. Keirans. 1992. Entomological Society of America, Lanham, Maryland. Thomas Say Foundation, volume 14, viii + 159 pp.

This monograph of a small (seven species) holarctic subgenus of ticks includes a systematic and phylogenetic study, summaries of host records and ecology, and a zoogeographic analysis. These ticks are parasites of small mammals and transmit piroplasms between rodents, although they are not vectors of Lyme Disease. The monograph was developed from the senior author's Ph.D. thesis at George Washington University.

The revisionary study includes no taxonomic changes in the subgenus—there are no new taxa, synonymies, or nomenclatorial changes. The species are fully described in all instars and illustrated with excellent scanning electron micrographs. Especially valuable to North American acarologists are the descriptions of the Old World species and analyses of the Russian literature. Differential diagnoses of the species and range maps are lacking, although very complete data are provided for all 3,851 specimens examined. The authors assume that readers are familiar with the specialized morphological terminology used in tick systematics, and indeed no key is presented to the subgenera of *Ixodes*. Readers should have at hand Clifford et al.'s (1973) subgeneric revision (in which *Ixodiopsis* keys to *Pholeoixodes*) and illustrations of key characters (e.g., Keirans and Clifford, 1978).

The authors claim that this is the first phylogenetic study of a taxon of ticks, although it is roughly contemporaneous with Klompen's (1992) phylogenetic analysis of argasid ticks based on larval characters. Twenty-two morphological characters are analyzed using Hennig86 and a single outgroup taxon, a species in the presumed sister subgenus *Pholeoixodes*. Although no technical information is provided concerning the computer-based analysis, the authors imply that a single most parsimonious cladogram results, with the seven species falling into two species groups.

In describing the subgenus *Ixodiopsis* and contrasting it with *Pholeoixodes*, the authors do not always distinguish plesiomorphous from apomorphic characters. In fact it is not evident that the six characters supporting *Ixodiopsis* are all apomorphies, especially since three undergo reversal within the subgenus. Most North American acarologists have placed *Ixodiopsis* as a synonym of *Pholeoixodes* (Clifford et al., 1973; Keirans and Clifford, 1978). Robbins and Keirans (1987) were the first North Americans to consider it distinct. Recognition of *Ixodiopsis* probably makes *Pholeoixodes* paraphyletic, as the authors knowledge.

A complete host list is provided for all species in the subgenus; most reported hosts are soricid insectivores and cricetid and arvicolid rodents. The ticks are en-

dophilic, completing their life cycles in host nests, and most species have restricted host ranges and occur only in cool moist climates. The exception is *Ixodes angustus*, the only holarctic species, which is common on a wide variety of hosts. The authors hypothesize that *I. angustus* is similar to the ancestral *Ixodiopsis*, although their phylogenetic analysis actually places it at the tip of one of the two clades.

The chapter of greatest interest to non-tick-specialists concerns zoogeography. The authors present an excellent overview of the formation and ecology of the Bering Land Bridge (Beringia) during the Pleistocene, and the resultant migration of mammals from Eurasia to North America. Based on the phylogenetic analysis and present distribution and host species of *Ixodiopsis*, speciation within the subgenus occurred 1.8–2.2 million years ago, and the subgenus dispersed across Beringia with the first modern microtine rodents. Subsequent speciation events were associated with host switches. These events are paralleled by radiation within the flea family Hystrichopsyllidae.

A hard-cover book of 159 pages may seem a lot to dedicate to only seven species of ticks which are of little direct importance to humans. On the other hand, a worldwide picture of a monophyletic taxon is the result, coupled with an evolutionary analysis based on cladistics, ecology, and geographic distribution.—George C. Eickworth, Department of Entomology, Comstock Hall, Cornell University, Ithaca, New York 14853-0999.

LITERATURE CITED

- Clifford, C. M., D. E. Sonenshine, J. E. Keirans and G. M. Kohls. 1973. Systematics of the subfamily Ixodinae (Acarina: Ixodidae). I. The subgenera of *Ixodes*. Ann. Entomol. Soc. Am. 66:489–500.
- Keirans, J. E. and C. M. Clifford. 1978. The genus *Ixodes* in the United States: a scanning electron microscope study and key to the adults. J. Med. Entomol. Suppl. 2:1–149.
- Klompen, J. S. H. 1992. Comparative morphology of argasid larvae (Acari: Ixodida: Argasidae), with notes on phylogenetic relationships. Ann. Entomol. Soc. Am. 85:541–560.
- Robbins, R. G. and J. E. Keirans. 1987. *Ixodes (Ixodiopsis) woodi* (Acari: Ixodidae): description of the larva and redescription of the nymph. J. Med. Entomol. 24:310–314.

J. New York Entomol. Soc. 101(3):438–441, 1993

A Synopsis of the Holarctic Miridae (Heteroptera): Distribution, Biology, and Origin, with Emphasis on North America—A. G. Wheeler, Jr. and Thomas J. Henry. 1992. Published by the Entomological Society of America (Lanham, Maryland) as Thomas Say Foundation Volume XV. [v+] 282 pp., 77 distribution maps, 31 figures (habitus line drawings). Hardback. ISBN 0-938522-39-6. Format: 15 by 22.5 cm. ESA Member Price US \$30.00. Nonmember Price US \$50.00, postpaid. Text in English.

"The study of the geographical distribution of insects is a subject which has received attention from many entomologists, yet one which is still in an infant stage of development."

(J. L. Gressitt, 1958)

Still, nearly a quarter of a century later, we find that little has changed. We have only, at best, a superficial knowledge of the insect fauna of North America. Not only do many species remain to be discovered or named, there are undoubtedly many more immigrant species among our fauna yet to be detected.

Because of the lack of sufficient comparative knowledge of the taxonomy of the forms occurring in both continents, few attempts have been made to estimate the faunal exchange between Europe and North America. The exceptions among the Insecta include such major groups as the Symphyta (Benson, 1962), Noctuidae (Mikkola et al., 1991), Carabidae (Lindroth, 1957; Larson and Langor, 1982), Dytiscidae (Larson and Nilsson, 1985), aleocharine Staphylinidae (Muona, 1984), Psylloidea (Hodkinson, 1980), and Cicadellidae (Hamilton, 1985).

Al Wheeler and Tom Henry, through their collective knowledge of North American plant bugs (the Miridae) and their many years of collecting, have produced a masterful treatise entitled "*A Synopsis of the Holarctic Miridae (Heteroptera): Distribution, Biology, and Origin, with Emphasis on North America.*"

The *Introduction* (Chapter 1) details the history of adventive insects in North America, and, more importantly, provides an overview of the primary literature focusing on adventive organisms as well as literature examples (using insect taxa) of comprehensive comparative analysis of species common to the Palearctic and Nearctic regions. The authors state their own philosophical rationale for why "Holarctic insects—adventive as well as indigenous species—merit attention."

Chapter 2, entitled *Holarctic Miridae in North America*, is divided into two parts. In *Review of Previous Work*, the reader is given a rather complete historical background on mirid studies, from the early to contemporary heteropteran workers who have studied the mirid faunas common to North America and Eurasia. In the section *Terminology and Organization*, the authors, so as to standardize their terminology, provide their definitions to such terms as "Holarctic, indigenous, introduced, and immigrant." Moreover, they also briefly explain how their information on Holarctic species is organized throughout the text.

The heart of the book, the account of species, comprises the remaining chapters (Chapters 3–7; corresponding to the mirid subfamilies). Under each subfamily category, genera are arranged alphabetically and species appear alphabetically within genera. For each species, the information presented appears under the following three headings (which are uniform and standardized throughout the text): *Distribution*—here the first North American record, a summary of recorded Nearctic distribution, new records based on the authors' recent collecting, and a summary of Old World distribution is provided; *Host Plants and Habits*—a review of information available for North America, any new biological data (again based on the authors' recent collecting), and selected Old World literature on habits and immatures; and finally *Zoogeography*—a review of published comments on the probable origin of each species in North America and any additional evidence lending to the interpretation of present-day distributions. "To give a better visual image of its Nearctic distribution pattern," the authors give distribution maps for each species (Maps 1–77). In addition, there is a beautiful frontispiece, and also high-quality line drawings of the habitus of 30 selected mirid species are interspersed among the text.

In the final chapter (Chapter 8, but erroneously labelled 7), entitled *Summary and*

Conclusions, a further comprehensive analysis and discussion of the Holarctic mirid fauna is provided.

Two different and extremely useful indices are presented to assist the reader: one is an index of arthropod names, and the other is an index of plant names (hosts of Holarctic mirids in North America).

The bibliography is amazingly complete and plethoric with more than 580 cited works on indigenous and adventive Miridae in the North Temperate zone.

In conclusion, Wheeler and Henry summarize information for 98 species of Miridae common to North America and the Old World, which are distributed in 5 subfamilies: Bryocorinae (4 species), Deraeocorinae (2 species), Mirinae (40 species), Orthotylinae (17 species), and Phylinae (35 species). They recognize 2 primary categories of North American Holarctic Miridae: an "indigenous element" comprising 37 species (recorded in List 1), and an "adventive element" of 61 species (recorded in Lists 2–5). The 5 lists appear as appendices at the end of the book.

In providing valuable data to basic and applied entomologists, ecologists, systematists, and regulatory personnel, the contents of this monograph by Wheeler and Henry represent one of the most comprehensive assessments of Holarctic members of any North American insect family.

If I have any criticism at all, it is mostly in points of detail. For a book of this length, one would expect to find numerous inconsistencies, typographical errors, or other errors in the text, but this is not the case. The few typographical errors noted include the obvious, inadvertent misspellings of several species names. *Tytthus pygmaeus* is "*Tytthus pymaeus*" in the caption of Figure 18 on p. 142. *Amblytylus nasutus* is "*Amyblytylus nasutus*" in the Hoebeke (1979) and Jewett and Spence (1944) citations of the References Cited section, pp. 233 and 234, respectively. Also, a very trivial point, the Latin phrase *incertae sedis*, meaning: of uncertain taxonomic position, appears as "*insertae sedis*" on p. 151.

One major criticism to be expressed concerns the line illustrations presented for the various mirid taxa. Including the splendid frontispiece of *Stethoconus japonicus*, there are 31 habitus drawings. The majority of these, borrowed from various works, are excellent in their reproduction, with the exception of Figure 19 (p. 149); some of the fine lines and details are lost in this full-page illustration of *Atractotomus magnicornis*. Indeed, habitus drawings of all 98 taxa discussed would have been ideal, but probably not practical. At the very least, a habitus figure of a representative species of *all* treated genera (namely 63 genus-group names) would have been preferred. Twenty habitus figures were of full page dimensions. The remaining 11 figures were reproduced at only half-page dimensions or even less; this was unfortunate as all could have been enlarged to full page.

For all 98 mirid species discussed in this work, both old and new records of North American distribution are given in the text and are plotted as solid and open dots, respectively, on distribution maps. In a number of cases, if one looks closely, there are some minor inconsistencies. For example, some old and/or new distribution records, although cited in the text, have not been plotted as dots on the accompanying maps (10 examples noted). While in other maps, old and/or new distribution records are plotted as dots but there is no accompanying locality data cited in the text (3 examples noted).

Despite these few criticisms, this book is indispensable to anyone at all interested

in the Miridae. Overall, the book must rate as a premier source of information on the plant bug fauna common to North America and Eurasia. In keeping with the style of the authors, this production is well written, superbly organized, and a truly informative reference that is "a must" on the shelves of all individuals and researchers interested in Miridae and Holarctic insect faunas. Among their concluding comments, the authors provide the following quote from Turnbull (1979:193): "How can we detect change in the future if we cannot define the fauna we now have?" With this challenge in mind, Al Wheeler and Tom Henry have done an admirable job in laying an important foundation for future investigators interested in faunal changes in North American Miridae. As it is, this work gives a tremendous wealth of information and the authors are to be congratulated.

For the price, the book is an excellent value, especially if an ESA member. However, it is a pity that the Thomas Say Foundation monographs, one of the showpieces of the Entomological Society of America, are not of higher quality. The text looks camera-ready, is printed on nonglossy paper and of small page dimensions, and is bound in a dull-ordinary, blue binding with no cover design. Can't the Entomological Society of America do better than this? This product could be better marketed if the overall production was vastly improved.—*E. Richard Hoebeke, Department of Entomology, Cornell University, Ithaca, New York 14853-0999.*

LITERATURE CITED

- Benson, R. B. 1962. Holarctic sawflies (Hymenoptera: Symphyta). Brit. Mus. Nat. Hist., Entomol. Ser., vol. 12, no. 8:381–409.
- Gressitt, J. L. 1958. Zoogeography of insects. Ann. Rev. Entomol. 3:207–230.
- Hamilton, K. G. A. 1985. Introduced and native leafhoppers common to the Old and New Worlds (Rhynchota: Homoptera: Cicadellidae). Can. Entomol. 115:473–511.
- Hodkinson, I. D. 1980. Present-day distribution patterns of the holarctic Psylloidea (Homoptera: Insecta) with particular reference to the origin of the nearctic fauna. J. Biogeogr. 7:127–146.
- Larson, D. J. and D. W. Langor. 1982. The carabid beetles of insular Newfoundland (Coleoptera: Carabidae: Cicindelidae)—30 years after Lindroth. Can. Entomol. 114:591–597.
- Larson, D. J. and A. N. Nilsson. 1985. The Holarctic species of *Agabus* (*sensu lato*) Leach (Coleoptera: Dytiscidae). Can. Entomol. 117:119–130.
- Lindroth, C. H. 1957. The Faunal Connections between Europe and North America. Wiley, New York, 344 pp.
- Mikkola, K., J. D. LaFontaine and V. S. Kononenko. 1991. Zoogeography of the Holarctic species of the Noctuidae (Lepidoptera): importance of the Beringian refuge. Entomol. Fenn. 2:157–173.
- Muona, J. 1984. Review of Palearctic Aleocharinae also occurring in North America (Coleoptera: Staphylinidae). Entomol. Scand. 15:227–231.
- Turnbull, A. L. 1979. Recent changes to the insect fauna of Canada. Pages 180–194 in: H. V. Danks (ed.), Canada and Its Insect Fauna. Mem. Entomol. Soc. Can. 108.

INSTRUCTIONS TO AUTHORS

The *Journal of the New York Entomological Society* publishes original research resulting from the study of insects and related taxa. Research that contributes information on taxonomy, classification, phylogeny, biogeography, behavior, natural history, or related fields will be considered for publication. The costs of publishing the Journal are paid by subscriptions, membership dues, page charges, and the proceeds from an endowment established with bequests from the late C. P. Alexander and Patricia Vaurie.

Manuscripts should be submitted in triplicate to: Dr. James M. Carpenter, Editor, Journal of the New York Entomological Society, Department of Entomology, American Museum of Natural History, Central Park West at 79th Street, New York, New York 10024. Contributions must be written in English, double-spaced (including references, tables, captions, etc.) and prepared in the format of a recent issue of the Journal. Manuscripts of any length will be considered for publication. Longer papers will be printed as articles, shorter ones as "scientific notes." Book reviews will be solicited by the Book Review Editor.

Longer manuscripts intended for submission as articles should be accompanied by a brief abstract. Footnotes should be avoided. Tables should be prepared as separate pages; they should be kept to a minimum because of the high cost of typesetting, but may be submitted as photographically reproducible material (see below). The list of references is headed "Literature Cited" and should follow the format indicated in the CBE Style Manual or as found in a recent issue of the Journal. Manuscripts should be printed in roman, bold roman, or underlined roman or bold roman to conform to journal typesetting style. Manuscripts should not contain any italic fonts. Manuscripts containing cladistic analyses should be accompanied by a copy of the data matrix on diskette for verification of the calculations.

Illustrations (originals whenever possible) should be submitted flat, never rolled or folded, with the manuscript. Size of illustrations should be kept manageable and suitable for shipment through the US mail without being damaged. Proportions of illustrations should conform to single column format, actual page size 11.5×17.5 cm. Please assemble illustrations in a compact fashion in order to use journal space effectively. *Mount line drawings and halftones on separate plates.* Figures should be numbered consecutively. Figure captions should be double-spaced, grouped together and placed at the end of the manuscript. If tables are submitted for photographic reproduction, they should be neat and clean and conform to journal format proportions.

Authors will receive page proofs, with the original manuscripts and illustrations, directly from the printer. Corrected proofs should be returned promptly to the Editor to avoid publication delays. Revisions in proof should be kept to the absolute minimum. *Alterations in proof will be charged to the author at the rate of \$3.25 per revision line.*

Society members will be charged a fee of \$23.00 per printed page and \$8.50 per plate of figures. Non-members will be charged \$65.00 per printed page and \$15.00 per plate of figures. Member authors who are students, or who do not have institutional affiliation may petition to the Society for waiver of page charges for no more than eight pages on a once a year basis. Because of limited funds, all such requests will be handled on a first-come first-serve basis.

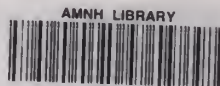
Authors will receive a reprint order blank with the proofs. Reprints are ordered directly from the printer with no benefit accruing to the Society.

Journal of the New York Entomological Society

Journal of the New York
Entomological Society
AM. MUS. NAT. HIST. LIBRARY
Received on: 10-26-93
59.57.06(74.7)

VOLUME 101

JU



100234042

CONTENTS

- The black flies of the genus *Simulium*, subgenus *Psilopelmia* (Diptera: Simuliidae), in the contiguous United States *B. V. Peterson* 301-390
- Two new genera for New World Veliinae (Heteroptera: Veliidae) *John T. Polhemus and Dan A. Polhemus* 391-398
- The genus *Dorcadothrips* (Thysanoptera: Thripidae) in Hawaii and North America with a description of a new species *Sueo Nakahara* 399-409
- Lestes secula*, a new species of damselfly (Odonata: Zygoptera: Lestidae) from Panama *Michael L. May* 410-416
- Discovery of the types of *Platistus spiniceps* (Herrich-Schäffer, 1840) and *Agroecus scabricornis* (Herrich-Schäffer, 1844), with a redescription of *Platistus* and its only included species, *P. spiniceps* (Heteroptera: Pentatomidae) *D. A. Rider* 417-423
- The first thrips species (Insecta) inhabiting leaf domatia: *Domatiathrips cunninghamii* gen. et sp. nov. (Thysanoptera: Phlaeothripidae) *Laurence A. Mound* 424-430
- Notes and Comments**
- Overlooked names in Nepomorpha, new synonymy, and a new name (Heteroptera: Corixidae, Notonectidae) *J. T. Polhemus* 431-433
- Synonymy of *Curicta howardi* Montandon with *Curicta scorpio* Stål (Heteroptera: Nepidae) *S. L. Keffer* 434-435
- Book Reviews**
- Classification, Cladistics, and Natural History of Native North American *Harpalus* Latreille (Insecta: Coleoptera: Carabidae: Harpalini), excluding subgenera *Glanodes* and *Pseudophonus* *James K. Liebherr* 436-437
- Systematics and Ecology of the Subgenus *Ixodiopsis* (Acari: Ixodidae: *Ixodes*) *George C. Eickwort* 437-438
- A Synopsis of the Holarctic Miridae (Heteroptera): Distribution, Biology, and Origin, with Emphasis on North America *E. Richard Hoebeke* 438-441